

Volume 1 of 2
Division 11 - 12

CONTRACT N40085-22-F-6938

NAVFAC SPECIFICATION

RR1 REPAIR BY REPLACEMENT
PROJECT # P1594

AT THE
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

DESIGN BY:

Public Works Design Division
Camp Lejeune, NC

OR

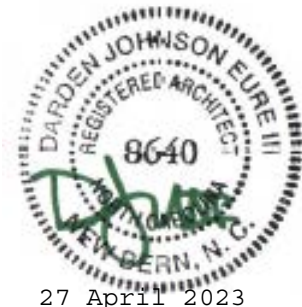
MBF ARCHITECTS, PA
NEW BERN, NORTH CAROLINA

A/E Contract: N40085-22-D-0002

SPECIFICATION PREPARED BY:

Darden J. Eure, III
MBF Architects, PA

Date: 27 April 2023



27 April 2023

SPECIFICATION APPROVED BY:

, Director
Design Branch, Public Works Division

, Commander, CEC, U.S. Navy
for Commander, Naval Facilities Engineering Command

This page is intentionally left blank.

VOLUME 1 - TABLE OF CONTENTS

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

00 01 15 02/11, CHG 1: 08/14 LIST OF DRAWINGS

DIVISION 01 - GENERAL REQUIREMENTS

01 11 00	07/21	SUMMARY OF WORK
01 12 00	07/21	CUTTING AND PATCHING
01 14 00	07/21	WORK RESTRICTIONS
01 20 00	07/21	PRICE AND PAYMENT PROCEDURES
01 30 00	07/21	ADMINISTRATIVE REQUIREMENTS
01 30 01.00 22	02/15	DESIGN, PROCUREMENT, AND INSTALLATION OF FURNITURE, FIXTURES, AND EQUIPMENT
01 31 50	07/21	TRANSFER AND ACCEPTANCE OF MILITARY REAL PROPERTY
01 32 16	07/21	CONSTRUCTION PROGRESS DOCUMENTATION
01 32 17.00 20	05/18, CHG 3: 08/20	COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS)
01 33 00	07/21	SUBMITTAL PROCEDURES
01 33 29	02/21	SUSTAINABILITY REQUIREMENTS AND REPORTING
01 35 29	07/21	SAFETY AND OCCUPATIONAL HEALTH REQUIREMENTS
01 42 00	07/21	SOURCES FOR REFERENCE PUBLICATIONS
01 45 00.00 20	11/11, CHG 8: 02/21	QUALITY CONTROL
01 45 35	11/20	SPECIAL INSPECTIONS
01 50 00	07/21	TEMPORARY FACILITIES AND CONTROLS
01 57 19	07/21	TEMPORARY ENVIRONMENTAL CONTROLS
01 60 00	07/21	REQUIREMENTS FOR PESTICIDE AND HERBICIDE COORDINATION
01 74 19	02/19, CHG 3: 11/21	CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
01 78 00	07/21	CLOSEOUT PROCEDURES
01 78 23	07/21	OPERATION AND MAINTENANCE DATA
01 78 30.00 22	07/21	GIS DATA DELIVERABLES
01 91 00.15 20	02/21, CHG 1: 05/21	TOTAL BUILDING COMMISSIONING

DIVISION 02 - EXISTING CONDITIONS

02 41 00 08/22 DEMOLITION

DIVISION 03 - CONCRETE

03 30 00	02/19, CHG 4: 08/22	CAST-IN-PLACE CONCRETE
03 30 53	05/14	MISCELLANEOUS CAST-IN-PLACE CONCRETE (SIDEWALKS)
03 45 00	05/16, CHG 2: 11/21	PRECAST ARCHITECTURAL CONCRETE

DIVISION 04 - MASONRY

04 20 00 11/15, CHG 2: 05/19 UNIT MASONRY

DIVISION 05 - METALS

05 12 00	08/18, CHG 2: 05/21	STRUCTURAL STEEL
05 30 00	05/15, CHG 2: 08/18	STEEL DECKS
05 40 00	05/15, CHG 1: 08/18	COLD-FORMED METAL FRAMING

05 51 00 02/17, CHG 1: 05/17 METAL STAIRS
05 52 00 02/18, CHG 1: 02/20 METAL RAILINGS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

06 10 00 08/16, CHG 2: 11/18 ROUGH CARPENTRY
06 61 16 08/20 SOLID SURFACING FABRICATIONS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 05 23 08/19 PRESSURE TESTING AN AIR BARRIER SYSTEM
FOR AIR TIGHTNESS
07 21 13 02/16, CHG 2: 08/20 BOARD AND BLOCK INSULATION
07 21 16 11/11, CHG 4: 08/18 MINERAL FIBER BLANKET INSULATION
07 22 00 02/16, CHG 3: 11/18 ROOF AND DECK INSULATION
07 27 10.00 10 08/19, CHG 1: 02/20 BUILDING AIR BARRIER SYSTEM
07 27 19.01 05/17, CHG 2: 08/20 SELF-ADHERING AIR BARRIERS
07 27 26 05/17, CHG 2: 08/20 FLUID-APPLIED MEMBRANE AIR BARRIERS
07 60 00 05/17, CHG 2: 11/18 FLASHING AND SHEET METAL
07 61 15.00 20 08/16, CHG 2: 11/18 ALUMINUM STANDING SEAM ROOFING
07 84 00 05/10, CHG 1: 08/13 FIRESTOPPING
07 92 00 08/16, CHG 3: 11/18 JOINT SEALANTS

DIVISION 08 - OPENINGS

08 11 13 08/20 STEEL DOORS AND FRAMES
08 14 00 08/16, CHG 1: 08/18 WOOD DOORS
08 34 73 11/19, CHG 1: 02/21 SOUND CONTROL DOOR ASSEMBLIES
08 41 13 08/18, CHG 1: 08/18 ALUMINUM-FRAMED ENTRANCES AND
STOREFRONTS
08 51 13 05/19 ALUMINUM WINDOWS
08 71 00 02/16, CHG 4: 02/22 DOOR HARDWARE
08 81 00 05/19 GLAZING
08 91 00 08/20 METAL LOUVERS

DIVISION 09 - FINISHES

09 22 00 02/10, CHG 2: 08/18 SUPPORTS FOR PLASTER AND GYPSUM BOARD
09 29 00 08/16, CHG 4: 02/20 GYPSUM BOARD
09 30 10 08/20 CERAMIC TILING
09 51 00 08/20 ACOUSTICAL CEILINGS
09 65 00 08/10, CHG 3: 08/18 RESILIENT FLOORING
09 67 23.13 11/19 STANDARD RESINOUS FLOORING
09 68 00 11/17, CHG 2: 08/20 CARPETING
09 90 00 02/21 PAINTS AND COATINGS

DIVISION 10 - SPECIALTIES

10 14 00.20 08/20 INTERIOR SIGNAGE
10 21 13 08/20 TOILET COMPARTMENTS
10 26 00 08/20 WALL AND DOOR PROTECTION
10 28 13 08/20 TOILET ACCESSORIES
10 44 16 11/19 FIRE EXTINGUISHERS

DIVISION 12 - FURNISHINGS

12 24 13 08/20 ROLLER WINDOW SHADES

DOCUMENT 00 01 15

LIST OF DRAWINGS
02/11, CHG 1: 08/14

PART 1 GENERAL

1.1 SUMMARY

This section lists the drawings for the project pursuant to contract clause "DFARS 252.236-7001, Contract Drawings, Maps and Specifications."

1.2 CONTRACT DRAWINGS

Contract drawings are as follows:

NAVFAC DWG NO.	SHEET NO.	TITLE
G GENERAL		
60038045	G-001	TITLE SHEET AND INDEX OF DRAWINGS
60038046	G-002	INDEX OF DRAWINGS CONTINUED
GI LIFE SAFETY		
60038047	GI001	BUILDING CODE/LIFE SAFETY ANALYSIS AND LEGEND
60038048	GI002	CODE COMPLIANCE SITE PLAN
60038049	GI101	FIRST FLOOR LIFE SAFETY PLAN
60038050	GI102	SECOND FLOOR LIFE SAFETY PLAN
C CIVIL		
60038051	C-001	CIVIL LEGEND, ABBREVIATIONS AND NOTES
60038052	CD101	SITE PLAN - EXISTING CONDITIONS AND DEMOLITION
60038053	CS101	SITE LAYOUT PLAN
60038054	CG101	SITE GRADING PLAN
60038055	CG102	SITE GRADING - SPOT ELEVATIONS AND FINISH CONTOURS
60038056	CU101	SITE UTILITY PLAN
60038057	CS501	DETAILS
60038058	CS502	DETAILS
60038059	CS503	DETAILS
60038060	CG501	DETAILS
60038061	CG502	EROSION CONTROL NOTES
60038062	CU501	DETAILS
LS LANDSCAPE		
60038063	L-101	SITE LANDSCAPING PLAN
S STRUCTURAL		
60038064	S-001	COVER SHEET
60038065	S-002	STRUCTURAL NOTES
60038066	S-101	FOUNDATION PLAN
60038067	S-102	SECOND FLOOR FRAMING PLAN
60038068	S-103	ROOF FRAMING PLAN
60038069	S-201	SECTIONS AND ELEVATIONS
60038070	S-202	SECTIONS AND ELEVATIONS
60038071	S-501	GENERAL CONSTRUCTION DETAILS
60038072	S-502	GENERAL CONSTRUCTION DETAILS
A ARCHITECTURAL		
60038073	A-001	SYMBOL LEGEND
60038074	A-101	FIRST FLOOR PLAN
60038075	A-101	FIRST FLOOR PLAN
60038076	A-102	SECOND FLOOR PLAN
60038077	A-103	FIRST FLOOR REFLECTED CEILING PLAN

NAVFAC	SHEET	
DWG NO.	NO.	TITLE
60038078	A-104	SECOND FLOOR REFLECTED CEILING PLAN
60038079	A-105	ROOF PLAN
60038080	A-106	AIR AND MOISTURE BARRIER PLANS
60038081	A-201	ELEVATIONS
60038082	A-202	ELEVATIONS
60038083	A-301	BUILDING SECTIONS
60038084	A-302	BUILDING SECTIONS
60038085	A-303	WALL SECTIONS
60038086	A-304	WALL SECTIONS
60038087	A-401	ENLARGED TOILET ROOM PLANS AND DETAILS
60038088	A-402	ENLARGED TOILET ROOM PLAN
60038089	A-403	ENLARGED TOILET ROOM PLAN
60038090	A-404	ENLARGED STAIR PLANS
60038091	A-405	ENLARGED STAIR PLANS
60038092	A-406	ENLARGED STAIR PLANS
60038093	A-407	ENLARGED STAIR AND RAMP PLANS
60038094	A-501	WALL TYPE DETAILS
60038095	A-502	MASONRY DETAILS
60038096	A-503	STAIR DETAILS
60038097	A-504	RAILING DETAILS
60038098	A-505	MISCELLANEOUS DETAILS
60038099	A-506	ROOFING DETAILS
60038100	A-507	ROOFING DETAILS
60038101	A-508	CAST STONE DETAILS
60038102	A-509	MISCELLANEOUS DETAILS
60038103	A-601	DOOR AND FRAME SCHEDULE
60038104	A-602	DOOR AND FRAME DETAILS
60038105	A-603	WINDOW SCHEDULE AND DETAILS
60038106	A-604	EXTERIOR FINISHES SCHEDULE
I INTERIOR DESIGN		
60038107	I-101	FIRST FLOOR FURNITURE PLAN
60038108	I-102	SECOND FLOOR FURNITURE PLAN
60038109	I-103	FIRST FLOOR FINISH PLAN
60038110	I-104	SECOND FLOOR FINISH PLAN
60038111	I-105	FIRST FLOOR WALL FINISH & SIGNAGE PLAN
60038112	I-106	SECOND FLOOR WALL FINISH & SIGNAGE PLAN
60038113	I-201	INTERIOR ELEVATIONS
60038114	I-202	INTERIOR ELEVATIONS
60038115	I-203	INTERIOR ELEVATIONS
60038116	I-501	SIGNAGE DETAILS
60038117	I-502	INTERIOR DETAILS
60038118	I-601	SCHEDULES & LEGENDS
60038119	I-602	SCHEDULES & LEGENDS
60038120	I-701	WORKSTATION TYPICALS
F FIRE PROTECTION		
60038121	FA001	FIRE ALARM GENERAL NOTES AND LEGEND
60038122	FA101	FIRST FLOOR FIRE ALARM PLAN
60038123	FA102	SECOND FLOOR FIRE ALARM PLAN
60038124	FA501	FIRE ALARM DETAILS
60038125	FA502	FIRE ALARM DETAILS
60038126	FA503	FIRE ALARM DETAILS
60038127	FX001	FIRE SUPPRESSION GENERAL NOTES AND LEGEND
60038128	FX101	FIRST FLOOR FIRE SUPPRESSION PLAN
60038129	FX102	SECOND FLOOR FIRE SUPPRESSION PLAN
60038130	FX501	FIRE SUPPRESSION DETAILS
P PLUMBING		
60038131	P-001	PLUMBING COVER SHEET

NAVFAC	SHEET	
DWG NO.	NO.	TITLE
60038132	P-101	FIRST FLOOR PLAN - WASTE AND VENT
60038133	P-102	FIRST FLOOR PLAN - WATER
60038134	P-103	SECOND FLOOR PLAN - WASTE AND VENT
60038135	P-104	SECOND FLOOR PLAN - WATER
60038136	P-201	ENLARGED PLAN - FIRST FLOOR - WASTE AND VENT
60038137	P-202	ENLARGED PLAN - FIRST FLOOR - WATER
60038138	P-203	ENLARGED PLAN - SECOND FLOOR - WASTE AND VENT
60038139	P-204	ENLARGED PLAN - SECOND FLOOR - WATER
60038140	P-501	PLUMBING DETAILS
60038141	P-601	PLUMBING SCHEDULES
60038142	P-701	RISER DIAGRAM - PLAN WEST - WASTE AND VENT
60038143	P-702	RISER DIAGRAM - PLAN EAST - WASTE AND VENT
60038144	P-703	RISER DIAGRAM - PLAN WEST - WATER
60038145	P-704	RISER DIAGRAM - PLAN EAST - WATER
M MECHANICAL		
60038146	M-001	MECHANICAL COVER SHEET
60038147	MH101	FIRST FLOOR PLAN - MECHANICAL
60038148	MH102	SECOND FLOOR PLAN - MECHANICAL
60038149	MP101	FIRST FLOOR PLAN - MECHANICAL PIPING
60038150	MP102	SECOND FLOOR PLAN - MECHANICAL PIPING
60038151	MH401	MECHANICAL ROOMS ENLARGED
60038152	MH402	MECHANICAL ROOMS ENLARGED
60038153	MP401	MECHANICAL ROOMS ENLARGED - MECHANICAL PIPING
60038154	MP402	MECHANICAL ROOMS ENLARGED - MECHANICAL PIPING
60038155	M-501	MECHANICAL DETAILS
60038156	M-502	MECHANICAL DETAILS
60038157	M-503	MECHANICAL DETAILS
60038158	M-504	MECHANICAL DETAILS
60038159	M-505	MECHANICAL DETAILS
60038160	M-506	MECHANICAL DETAILS
60038161	M-507	MECHANICAL DETAILS
60038162	M-508	MECHANICAL DETAILS
60038163	M-601	MECHANICAL SCHEDULES
60038164	M-602	MECHANICAL SCHEDULES
60038165	M-603	MECHANICAL SCHEDULES
60038166	M-701	MECHANICAL CONTROLS
60038167	M-702	MECHANICAL CONTROLS
60038168	M-703	MECHANICAL CONTROLS
60038169	M-704	MECHANICAL CONTROLS
60038170	M-705	MECHANICAL CONTROLS
60038171	M-706	MECHANICAL CONTROLS
60038172	M-707	MECHANICAL CONTROLS
60038173	M-708	HOT WATER SYSTEM DIAGRAM
60038174	M-709	CHILLED WATER SYSTEM DIAGRAM
ES ELECTRICAL SITE		
60038175	ES101	SITE PLAN - ELECTRICAL
60038176	ES501	SITE ELECTRICAL DETAILS
60038177	ES502	SITE ELECTRICAL DETAILS
60038178	ES503	SITE ELECTRICAL DETAILS
E ELECTRICAL		
60038179	E-001	ELECTRICAL NOTES AND LEGENDS
60038180	E-101	FIRST FLOOR PLAN - POWER
60038181	E-102	SECOND FLOOR PLAN - POWER
60038182	E-103	FIRST FLOOR PLAN - LIGHTING
60038183	E-104	SECOND FLOOR PLAN - LIGHTING
60038184	E-105	ROOF PLAN - LIGHTNING PROTECTION
60038185	E-401	ENLARGED FIRST FLOOR PLANS

NAVFAC	SHEET	
DWG NO.	NO.	TITLE
60038186	E-402	ENLARGED SECOND FLOOR PLANS
60038187	E-501	ELECTRICAL DETAILS
60038188	E-502	ELECTRICAL DETAILS
60038189	E-503	ELECTRICAL DETAILS
60038190	E-504	ELECTRICAL DETAILS
60038191	E-601	ELECTRICAL SCHEDULES
60038192	E-602	ELECTRICAL SCHEDULES
60038193	E-603	ELECTRICAL SCHEDULES
60038194	E-604	ELECTRICAL SCHEDULES
60038195	E-605	ELECTRICAL SCHEDULES
60038196	E-606	ELECTRICAL SCHEDULES
60038197	E-701	ELECTRICAL RISER DIAGRAM
T TELECOMMUNICATIONS		
60038198	T-001	TELECOMMUNICATIONS NOTES AND LEGENDS
60038199	T-101	FIRST FLOOR PLAN - TELECOMMUNICATIONS
60038200	T-102	SECOND FLOOR PLAN - TELECOMMUNICATIONS
60038201	T-501	TELECOMMUNICATION DETAILS
60038202	T-502	TELECOMMUNICATION DETAILS
60038203	T-503	TELECOMMUNICATION DETAILS

-- End of Document --

SECTION 01 11 00

SUMMARY OF WORK

07/21

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

1.1.1 Project Description

The work includes a new 2-Story H style building on the existing site for Rifle Range Building 1.

and incidental related work.

1.1.2 Location

The work shall be located at the Rifle Range building 1 (RR1), Stone Bay approximately as shown. The exact location will be indicated by the Contracting Officer.

1.2 EXISTING WORK

In addition to "FAR 52.236-9, Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements":

- a. Remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain.
- b. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Contracting Officer. At the completion of operations, existing work shall be in a condition equal to or better than that which existed before new work started.

1.3 LOCATION OF UNDERGROUND FACILITIES

The Contractor will be responsible for obtaining the services of a professional utility locator to scan the construction site with electromagnetic or sonic equipment, and mark the surface of the ground where existing underground utilities are discovered. Verify the elevations of existing piping, utilities, and any type of underground obstruction not indicated or specified to be removed but indicated or discovered during scanning in locations to be traversed by piping, ducts, and other work to be installed. Verify elevations before installing new work closer than nearest manhole or other structure at which an adjustment in grade can be made.

1.3.1 Notification Prior to Excavation

Notify the Contracting Officer 48 hours prior to starting excavation work

in order to permit making arrangements with public works personnel to scan the area for unmarked utilities. Obtain station digging permits prior to starting excavation work.

1.4 MERCHANTABLE TIMBER REMOVAL

The Government will have the option to remove merchantable timber from the construction site prior to the Contractor starting his clearing operations. The Contractor shall provide the Government a minimum 3 weeks written notice prior to the start of his clearing operations. The Government will take approximately 2 weeks to remove the merchantable timber, and will leave approximately 2 feet of stump for Contractor removal. Stumps, limbs, and smaller trees shall be left on site for the Contractor to dispose of. Merchantable timber shall remain the property of the Government.

1.5 EMERGENCY UNEXPLODED ORDNANCE (UXO) RESPONSE

In the event that UXO, as defined in 40 CFR 260 is encountered during the construction activities that are deemed to be a threat to human health or the environment, Camp Lejeune Military Police and EOD professionals shall be immediately contacted to conduct an emergency response. Additionally, immediately contact the Contracting Officer if UXO is encountered. An evaluation of this scenario and procedures, with contract numbers, shall be included in the Health and Safety Plan (HASP) for the fieldwork.

1.5.1 3R TRAINING

All Contractor personnel performing ground disturbing activities must complete contractor awareness training related to recognizing UXO. This training (3R TRAINING) is available online at:

<http://www.lejeune.marines.mil/OfficesStaff/EnvironmentalMgmt/TrainingVideo.aspx>

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 12 00

CUTTING AND PATCHING

07/21

PART 1 GENERAL

1.1 CUTTING

Shall be done by sawing along straight lines. The amount cut out shall be the minimum necessary to accommodate the new work. No flame cutting will be permitted without written permission of the Officer in Charge of Construction.

1.2 HOLES

Shall be rotary drilled. The size shall be the minimum necessary to accommodate the new work.

1.3 PATCHING

Shall be done with materials which match the existing in color, quality and surface texture when finished.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 14 00

WORK RESTRICTIONS

07/21

PART 1 GENERAL

1.1 CONTRACTOR ACCESS AND USE OF PREMISES

1.1.1 Station Regulations

Ensure that Contractor personnel employed on the Station become familiar with and obey Station regulations. Keep within the limits of the work and avenues of ingress and egress as directed. Do not enter restricted areas unless required to do so and until cleared for such entry. Wear hard hats in designated areas. Do not enter any restricted areas unless required to do so and until cleared for such entry. The Contractor's equipment shall be conspicuously marked for identification.

1.1.2 Working Hours

Regular working hours shall consist of an eight and one-half hour period established by the Contracting Officer, Monday through Friday, excluding Government holidays.

1.1.3 Work Outside Regular Hours

Work outside regular working hours requires Contracting Officer approval. Provide written request at least 15 calendar days prior to such work to allow arrangements to be made by the Government for inspecting the work in progress. During periods of darkness, the different parts of the work shall be lighted in a manner approved by the Contracting Officer.

1.1.4 Utility Cutovers and Interruptions

- a. Make utility cutovers and interruptions after normal working hours or on Saturdays, Sundays, and Government holidays. Conform to procedures required in the paragraph "Work Outside Regular Hours."
- b. Ensure that new utility lines are complete, except for the connection, before interrupting existing service.
- c. Interruption to water, sanitary sewer, storm sewer, telephone service, electric service, air conditioning, heating, fire alarm, compressed air shall be considered utility cutovers pursuant to the paragraph entitled "Work Outside Regular Hours." This time limit includes time for deactivation and reactivation.
- d. Operation of Station Utilities: The Contractor shall not operate nor disturb the setting of control devices in the station utilities system, including water, sewer, electrical, and steam services. The Government will operate the control devices as required for normal conduct of the work. The Contractor shall notify the Contracting Officer giving reasonable advance notice

RR1 Repair by Replacement
MCB Camp Lejeune, NC

Project# P1594
27 April 2023

when such operation is required.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 20 00

PRICE AND PAYMENT PROCEDURES

07/21

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 the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

EP 1110-1-8 (2016) Construction Equipment Ownership
and Operating Expense Schedule

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00, "Submittal Procedures."

SD-01 Preconstruction Submittals

Schedule of prices

1.3 SCHEDULE OF PRICES

1.3.1 Data Required

Within 15 calendar days of notice of award, prepare and deliver to Contracting Officer a schedule of prices (construction contract) on the forms furnished by the Government. Provide a detailed breakdown of the contract price, giving quantities for each of the various kinds of work, unit prices, and extended prices therefor. Schedule of prices shall be separated by individual building numbers with subtotals for each building.

1.3.2 Schedule Instructions

Payments will not be made until the schedule of prices has been submitted to and approved by the Contracting Officer. Identify the cost for site work, and include incidental work to the 5 foot line. Identify costs for the building(s), and include work out to the 5 foot line. Work out to the 5 foot line shall include construction encompassed within a theoretical line 5 feet from the face of exterior walls and shall include attendant construction, such as cooling towers, placed beyond the 5 foot line.

1.3.3 Schedule Requirements for HVAC TAB

The field work Section 23 05 93, "HVAC Testing/Adjusting/Balancing" shall be broken down in the Schedule of Prices and in the Construction Progress Documentation by separate line items which reflect measurable deliverables. Specific payment percentages for each line item shall be

determined on a case by case basis for each contract. The line items shall be as follows:

- a. Approval of Design Review Report: The TABS Agency is required to conduct a review of the project plans and specifications to identify any feature, or the lack thereof, that would preclude successful testing and balancing of the project HVAC systems. The resulting findings shall be submitted to the Government to allow correction of the design. The progress payment shall be issued after review and approval of the report.
- b. Approval of the pre-field engineering report: The TABS Agency submits a report which outlines the scope of field work. The report shall contain details of what systems will be tested, procedures to be used, sample report forms for reporting test results and a quality control checklist of work items that must be completed before TABS field work commences.
- c. Season I field work: Incremental payments are issued as the TABS field work progresses. The TABS Agency mobilizes to the project site and executes the field work as outlined in the pre-field engineering report. The HVAC water and air systems are balanced and operational data shall be collected for one seasonal condition (either summer or winter depending on project timing).
- d. Approval of Season I report: On completion of the Season I field work, the data is compiled into a report and submitted to the Government. The report is reviewed, and approved, after ensuring compliance with the pre-field engineering report scope of work.
- e. Completion of Season I field QA check: Contract QC and Government representatives meet the TABS Agency at the jobsite to retest portions of the systems reported in the Season I report. The purpose of these tests are to validate the accuracy and completeness of the previously submitted Season I report.
- f. Approval of Season II report: The TABS Agency completes all Season II field work, which is normally comprised mainly of taking heat transfer temperature readings, in the season opposite of that under which Season I performance data was compiled. This data shall be compiled into a report and submitted to the Government. On completion of submittal review to ensure compliance with the pre-field engineering report scope, progress payment is issued. Progress payment is less than that issued for the Season I report since most of the water and air balancing work effort is completed under Season I.

1.4 CONTRACT MODIFICATIONS

In conjunction with the Contract Clause "DFARS 252.236-7000, Modification Proposals-Price Breakdown," and where actual ownership and operating costs of construction equipment cannot be determined from Contractor accounting records, equipment use rates shall be based upon the applicable provisions of the [EP 1110-1-8](#).

1.5 CONTRACTOR'S PAYMENT REQUEST

1.5.1 Proper Payment Request

A proper request for payment/invoice shall comply with all requirements specified in this Section and the contract payment clauses. If any invoice does not comply with these requirements, it shall be returned with a statement of the reasons why it was not a proper invoice. A proper payment request/invoice includes the following information, completed forms, and number of copies indicated. Upon request, the Contracting Officer will furnish copies of Government forms.

- a. Contractor's Invoice on NAVFAC Form 7300/30, which shall show the basis for arriving at the amount of the invoice. Submit one original and two copies.
- b. Contractor's Monthly Estimate for Voucher (LANTNAVFACENGCOM Form 4-4330/110. Submit original and two copies.
- c. Payment Certification. Furnish as specified in "FAR Clause 52.232-5 (c) Payments under Fixed-Price Construction Contracts." Submit one original.
- d. QC Invoice Certification. Furnish as specified in Section 01 45 00.00 20 QUALITY CONTROL,. Submit one original.

1.5.1.1 Progress Payments

In addition to the requirements stated in Paragraph 1.5.1, "Proper Payment Request" above, the Contractor's request for progress payments shall include the following:

- a. Updated Progress Schedule: Furnish an updated progress schedule as specified in contract clause FAR 52.236-15 "Schedules for Construction Contracts" and Section 01 32 16, "Construction Progress Documentation." Submit one copy.

1.5.1.2 Final Payments

The request for final payment is submitted after completion and acceptance of all work and all other requirements of the contract. Before submitting the final invoice the Contractor shall meet with the appropriate Government representatives to determine the final invoice amount, including the assessment of liquidated damages, if any, and to make sure the final release is complete and accurate. In addition to the requirements in Paragraph 1.5.1, "Proper Payment Request" above, the Contractor's request for final payment shall include the following:

- a. A final release executed on the standard form provided by the Contracting Officer. Submit two originals with final payment request.
- b. NC Tax certified statement and report for the prime and each subcontractor (FAR 52.229-7). Submit two copies.
- c. As-built drawings (if applicable).
- d. Warranties (if applicable).

- e. O&M manuals (if applicable).
- f. Final payrolls (FAR 52.222-6).
- g. A release for an assignment of claims (if applicable). Submit three originals.

1.5.2 Procedures for Submitting Payment Request

- a. The Contractor may submit only one invoice for payment each month as the work progresses.
- b. The invoice shall be delivered to the ROICC Office, Administrative Branch, between five calendar days before and five calendar days after the contract award date. Invoices received outside this schedule shall be returned to the Contractor unprocessed. The Contractor will have to wait until the following month to submit their next invoice.
- c. Invoices shall be delivered during normal work hours from 7:30 AM up to 4:00 PM (EST), Monday through Friday, excluding holidays.

1.6 PAYMENTS TO THE CONTRACTOR

Payments will be made on submission of a proper payment request/invoice by the Contractor.

1.6.1 Obligation of Government Payments

The obligation of the Government to make payments required under the provisions of this contract will, at the discretion of the Contracting Officer, be subject to the following:

- a. Reasonable retention and/or deductions due to defects in material or workmanship; potential liquidated damages; and/or failure to comply with any other requirements of the contract.
- b. Claims which the Government may have against the Contractor under or in connection with this contract; and
- c. Unless otherwise adjusted, repayment to the Government upon demand for overpayments made to the Contractor.
- d. Failure to provide up to date record drawings not current as stated in Contract Clause "FAC 5252.236-9310, Record Drawings"; NC State tax certified statement and report in accordance with FAR 52.229-2; labor payrolls in accordance with FAR 52.222-6; as-built drawings in accordance with Section 01 45 00.00 20 QUALITY CONTROL; warranties and O&M manuals; and any other requirements in the contract.

1.6.2 Payment for Onsite and Offsite Materials

Progress payments may be made to the contractor for materials delivered on the site, for materials stored off construction sites, or materials that are in transit to the construction sites under the following conditions:

- a. FAR 52.232-5(b) Payments Under Fixed Price Construction Contracts.

- b. Materials delivered on the site but not installed, including completed preparatory work, and off- site materials to be considered for progress payment shall be major high cost, long lead, special order, or specialty items, not susceptible to deterioration or physical damage in storage or in transit to the construction site. Examples of materials acceptable for payment considerations include, but are not limited to, structural steel, non-magnetic steel, non-magnetic aggregate, equipment, machinery, large pipe and fittings, precast/ prestressed concrete products, plastic lumber (e.g. fender piles/ curbs), and high-voltage electrical cable. Materials no acceptable for payment include consumable materials such as nails, fasteners, conduits, gypsum board, glass, insulation, and wall coverings.
- c. Materials to be considered for progress payment prior to installation shall be specifically and separately identified in the Contractor's estimates of work submitted for the Contracting Officer's approval in accordance with Earned Value Report requirement of this contract. Requests for progress payment considerations for such items shall be supported by documents establishing their value and that the title requirements of the clause at FAR 52.232-5 have been met.
- d. Materials are adequately insured and protected from theft and exposure.
- e. Provide a written consent from the surety company with each payment request for offsite materials.
- f. Materials to be considered for progress payments prior to installation shall be stored in the Continental United States.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 30 00

ADMINISTRATIVE REQUIREMENTS

07/21

PART 1 GENERAL

1.1 SUBMITTALS

Submit the following in accordance with the Section 01 33 00, "Submittal Procedures."

SD-01 Preconstruction Submittals

List of contact personnel

1.2 MINIMUM INSURANCE REQUIREMENTS

Procure and maintain during the entire period of performance under this contract the following minimum insurance coverage:

- a. Comprehensive general liability: \$500,000 per occurrence
- b. Automobile liability: \$200,000 per person, \$500,000 per occurrence, \$20,000 per occurrence for property damage
- c. Workmen's compensation as required by Federal and State workers' compensation and occupational disease laws,
- d. Employer's liability coverage of \$100,000, except in States where workers compensation may not be written by private carriers,
- e. Others as required by State law.

1.3 ELECTRONIC MAIL (EMAIL)

- a. The Contractor is required to establish and maintain electronic mail (email) capability along with the capability to open various electronic attachments in Microsoft, Adobe Acrobat, and other rsimilar formats.
- b. Within 10 days after contract award; the Contractor shall provide the Contracting Officer a single (only one) email address for the ROICC office to send communications related to this contract correspondence. The ROICC office may also use email to notify the Contractor of base access conditions when emergency conditions warrant, such as hurricanes, terrorist threats, etc.
- c. Multiple email addresses are not authorized.
- d. It is the Contractor's responsibility to make timely distribution of all ROICC email within its own organization, including field office(s).
- e. The Contractor shall promptly notify the Contracting Officer, in

writing, of any changes to their email address.

1.4 CONTRACTOR PERSONNEL REQUIREMENTS

1.4.1 Subcontractors and Personnel

Furnish a list of contact personnel of the Contractor and subcontractors including addresses and telephone numbers for use in the event of an emergency. As changes occur and additional information becomes available, correct and change the information contained in previous lists.

1.4.2 Identification Badges

Identification badges will be furnished without charge. Application for and use of badges will be as directed below. Immediately report instances of lost or stolen badges to the Contracting Officer. Employees are required to resubmit a complete 50 state criminal records check in order to renew their contractor badge.

1.4.3 Business Access Security Requirements

1.4.3.1 Business Access Definition

Contractor/subcontractor employees requiring installation access to MCB, Camp Lejeune or MCAS New River, N.C. must obtain a Business Access Identification Badge for that particular installation. Regularly scheduled delivery personnel, to include FEDEX, UPS, Pick-up and deliveries, should, also, follow the Business Access guidelines described below. Personnel requiring Business Access Identification Badges shall submit all documentation listed below. Badges are not required if the contracted position requires the employee to obtain a Common Access Card (CAC) which will be identified separately within the Government contract.

1.4.3.2 Installation Security Access Requirements

Contractor shall accomplish the security requirements below within 10 days after award or prior to performance under the contract.

1.4.3.3 Business Access Identification Badge Requirement

In order to obtain a Business Access Identification Badge for access to MCB, Camp Lejeune, and satellite activities, or MCAS New River, NC, all personnel providing services under this contract shall be required to present the documentation below to the following offices, as applicable:

MCB, Camp Lejeune, NC and its satellite activities. Report as follows:

1. Identification Card Center, 60 Molly Pitcher Road for badge (910-450-8444).

MCAS New River, NC. Report as follows:

1. Pass and Identification Office, Bldg AS-187 for badge (910-449-7695) and vehicle pass (910-449-5513).

1.4.3.4 Proof of Employee Citizenship or Legal Alien Status

Employers may participate in the E-verify program (1-888-464-4218, www.DHS.gov/e-verify) allowing U.S. employers to verify name, DOB, and SSN

along with immigration information for non-citizens, against federal databases in order to verify the employment eligibility of both citizens and non-citizen new hires.

1.4.3.5 Proof of Criminal Records Check

Commercial and contract employees must provide proof a complete 50 state criminal records check on an annual basis. The record check may be obtained from any of the following Internet investigative services: Kroll (former Infolink Screening Services) at www.kroll.com, Castle Branch at www.castlebranch.com, or any other investigative services company that provides records checks for all 50 states. These services also validate social security card numbers. All criminal history checks must be completed no more than 30 days prior to start date of contract. (Note: These Internet screening services are listed as possible sources for obtaining a criminal background check. The United States government and the United States Marine Corps do not endorse nor are they affiliated with any of these services).

1.4.3.6 Letter Provided By Contracting Officer Indicating Contract

Letter provided by Contracting Officer indicating contract, contract period and prime contractor. Proof of employment on a valid Government contract (e.g., a letter on company letterhead from the prime contractor including contract number and term).

1.4.3.7 Photo ID

Valid state or federal issued picture identification card. Acceptable documents include state drivers license, DMV issued photo identification, or alien registration card.

1.4.3.8 National Crime Investigation Center (NCIC) Check

Provost Marshals are authorized to conduct a national crime information center (NCIC) check of all persons entering the installation, if/where applicable, the NCIC check may include drivers's license query, wants and warrants, and criminal history.

1.4.4 Denial of Access

Installation access shall be denied if it is determined that an employee:

- a. Is on the National Terrorist Watch List
- b. Is illegally present in the United States.
- c. Is subject to an outstanding warrant.
- d. Has knowingly submitted an employment questionnaire with false or fraudulent information.
- e. Has been issued a debarment order and is currently banned from military installations.
- f. Is a Registered Sexual Offender.
- g. Has been convicted of a felony or a drug crime within the past five years.

- h. Individuals who have received a DUI/DWI in the last year may be allowed access to the installation, but will not be permitted to drive on the installation.
- i. Any reason the Installation Commander deems reasonable for the good order and discipline.

1.4.5 Appeal Process

All appeals should be directed to the Base Inspector's Office for any individual that has been denied access to the Base.

1.4.6 Display of Badges

Contractors/subcontractors shall prominently display their badges on their person at all times. Upon completion/termination of this contract or an individual's employment, the Contractor shall collect and turn in to the Pass & ID Office all badges. If the Contractor fails to obtain the employee's badge, the Pass & ID Office will be notified within 24 hours. Immediately report instances of lost or stolen badges to the Contracting Officer.

1.4.7 Contractor and Subcontractor Vehicle Requirements

Each vehicle to be used in contract performance shall show the Contractor's or subcontractor's name so that it is clearly visible and shall always display a valid state license plate and safety inspection sticker. To obtain a vehicle decal, which will be valid for one year or contract period, whichever is shorter, Contractor or subcontractor vehicle operators shall provide to the Vehicle Registration Office, 60 Molly Pitcher Road (910-451-1158) or to MCAS, Building AS-187 (910-449-5513) for vehicle decal:

- a. An installation sponsor request forwarded to provost Marshall office
- b. A valid form of Federal or state government I.D.
- c. If driving a motor vehicle, a valid driver's license, vehicle registration and proof of insurance

Upon completion/termination of this contract or an individual's employment, the Contractor shall collect and turn in to Vehicle Registration all Government vehicle decals. If any are not collected, the Contractor shall notify the Vehicle Registration Office within 24 hours.

1.4.8 Security Checks

Contractor personnel and vehicles shall only be present in locations relevant to contract performance. All Contractor personnel entering the base shall conform to all Government regulations and are subject to such checks as may be deemed necessary to ensure that violations do not occur. Employees shall not be permitted on base when such a check reveals that their presence would be detrimental to the security of the base. Subject to security regulations, the Government will allow access to an area for servicing equipment and/or performing required services. Upon request, the Contractor shall submit to the Contracting Officer questionnaires and other forms as may be required for security purposes.

1.4.9 Subcontractor Special Requirements

1.4.9.1 Space Temperature Control, HVAC TAB, and Apparatus Inspection

All contract requirements of Section 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC, 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and 26 08 00 APPARATUS INSPECTION AND TESTING shall be accomplished directly by a first tier subcontractor. No work required by Sections above shall be accomplished by a second tier subcontractor.

1.4.9.2 Telecommunication and High Voltage Work

When telecommunications and high voltage work is required, all work associated with telecommunications and high voltage shall be accomplished by a first tier subcontractor. The contractor must possess a valid North Carolina Public Utility - Electrical, contractor's license and be insured to do such work in the State of North Carolina.

1.4.9.3 Paving Associated with Utility Cuts

All pavement repairs associated with utility cuts shall be completed within 14 days of completing work within paved area.

1.5 DISCLOSURE OF INFORMATION

Contractor shall comply as follows:

- (a) The Contractor shall not release to anyone outside the Contractor's organization any unclassified information, regardless of medium (e.g., film, tape, document), pertaining to any part of this contract or any program related to this contract, unless -

- (1) The Contracting Officer has given prior written approval; or

- (2) The information is otherwise in the public domain before the date of release.

- (b) Requests for approval shall identify the specific information to be released, the medium to be used, and the purpose for the release. The Contractor shall submit its request to the Contracting Officer at least 45 days before the proposed date for release.

- (c) The Contractor agrees to include a similar requirement in each subcontract under this contract. Subcontractors shall submit requests for authorization to release through the prime contractor to the Contracting Officer.

1.6 SUPERVISION

Have at least one qualified supervisor capable of reading, writing, and conversing fluently in the English language on the job site during working hours. In addition, if a Quality Control (CQ) representative is required on the contract, then that individual shall also have fluent English communication skills.

1.7 PRECONSTRUCTION CONFERENCE

After award of the contract but prior to commencement of any work at the site, meet with the Contracting Officer to discuss and develop a mutual understanding relative to the administration of the value engineering and safety program, preparation of the schedule of prices, shop drawings, and other submittals, scheduling programming, and prosecution of the work. Major subcontractors who will engage in the work shall also attend. The Engineer of Record shall attend this meeting.

1.8 ENGINEER OF RECORD CONSTRUCTION SITE VISITS

To increase the likelihood of successful performance of this contract, the Government requires the Engineer of Record to provide construction site visits during the project. This project will require the following site visits:

1. Site visit nearing completion of demolition/salvage
2. Site visit after installation of Generators and Platforms.
3. Site visit after project is complete, Final Punchlist

These site visits shall be completed prior to turning the project over to the government.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 30 01.00 22

DESIGN, PROCUREMENT, AND INSTALLATION OF FURNITURE, FIXTURES, AND EQUIPMENT
02/15

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. 01 33 00 SUBMITTAL PROCEDURES

SD-01 Preconstruction Submittals

Preliminary (Pre-Final) FF&E Package; G, ID NAVFAC MidLant Interior Design

FF&E Schedule and Schedule Updates; G, ID NAVFAC MidLant Interior Design

FF&E Concept Presentation Submittal / Over The Shoulder Review;; G, ID NAVFAC MidLant Interior Design

Final FF&E Package; G, ID NAVFAC MidLant Interior Design

Contractor's Interior Designer's Qualifications; G, ID NAVFAC MidLant Interior Design

Best Value Determination; G, ID NAVFAC MidLant Interior Design

1.2 GENERAL REQUIREMENTS

Furnishings, Fixtures, and Equipment (FF&E) includes, but is not limited to items such as; systems and modular furniture, desks, workstations, seating, storage, filing, visual display items, accessories, artwork, training and conference furniture, soft window treatments, shop equipment, dorm and quarters furnishings and other miscellaneous items to support facility functions. Weapon racks, drying cages, and lockers are not typically considered FF&E. FF&E must be fully integrated with the building systems and finishes. FF&E may also include specialty items for which the customer activity will be responsible for specifying.

The design and documentation of the FF&E must be funded as Interior Design Services and included in the Base Bid. The purchase and installation of the FF&E Package must be funded separately as an option. The Government FF&E estimates on the SECTION 00 22 13.00 20 SUPPLEMENTARY INSTRUCTIONS to OFFERORS (Bid Schedule/Price Proposal Form) for the FF&E option is \$780,966.00 and does NOT include the Contractor's Handling and Administration Rate (HAR). This Government FF&E estimate must not be altered by Contractors during the bid process.

All FF&E items are subject to the Buy American Act or Trade Agreement Act, unless they are considered COTS (Consumer Off The Shelf) items.

1.3 INTERIOR DESIGN SERVICES

1.3.1 Qualifications and Affiliations

Per UFC 3-120-10, The Prime Contractor must provide the services of an Interior Designer with the following qualifications. The Prime Contractor's Interior Designer, must be certified by the National Council for Interior Design Qualification (NCIDQ), must have attained certification, registration or licensure and must have experience as the primary interior designer on projects of similar type, size, scope and complexity. Experience writing non-proprietary, technical performance criteria for competitive furniture bids and experience analyzing competitive furniture bid proposals, is required and must be clearly indicated in resume. The Prime Contractor's Interior Designer, Design Firm owners, and any Specialists must NOT have any affiliation or partnership with any furniture, fixture, or equipment products, any furniture dealership or manufacturers. Additionally, the Prime Contractor is required to use the services of an Interior Designer other than the A/E's Interior Designer who developed the Concept FF&E Package. Provide a detailed resume, client references and documentation of the Prime Contractor's Interior Designer's qualifications and significant interior design experience to the NAVFAC Interior Designer PRIOR to the Kick-off/Partnering Meeting. The Government will approve/disapprove the Prime Contractor's Interior Designer based on the provided documentation and past performance. Provide written documentation of contractor's interior designer's qualifications.

1.3.2 Concept FF&E package

A basic concept FF&E package, prepared by the A/E's Interior Designer, indicating the salient characteristics of all required FF&E items, will be provided to the Prime Contractor. The Prime Contractor's Interior Designer must further develop and revise this concept package, as required, to prepare/provide a final, best valued FF&E package, in accordance with the requirements in this document. The Prime Contractor must provide the Contractor's Interior Designer a complete set of the construction drawings (CAD files) prior to commencement of work on the project.

1.3.3 FF&E Schedule

For all projects, including fast track projects and renovations, the Prime Contractor is responsible for sufficiently scheduling all FF&E meetings and deliverables early enough to:

- a. Obtain the required government approvals
- b. Meet all FF&E ordering and installation lead times
- c. Complete the FF&E installation by the contract completion date

All submittal due dates for the FF&E must be noted in the FF&E Schedule and reflected in the Prime Contractor's construction schedule. A proposed FF&E schedule for all FF&E Services and Deliverables must be provided to the Construction Manager, NAVFAC Interior Designer and Contracting Officer seven business days after the Interior Design Orientation Meeting. An FF&E Schedule Guideline template is available from the NAVFAC Interior Designer, for your use in developing a schedule. FF&E schedule and schedule updates must be submitted as the construction schedule is

revised. The Final FF&E package must be submitted four months prior to the funding deadline (to be determined by funding source) and approved no later than nine months prior to the Contract Completion Date.

1.3.4 FF&E and CEQ (Collateral Equipment) Services

The Contractor's Interior Designer and Equipment Specialists are responsible for developing equipment packages for FF&E and other specialty equipment, i.e. shop equipment, kitchen equipment, fitness equipment, laboratory equipment, medical equipment, high density storage, etc., required in the project. The Contractor must obtain the services of equipment specialists to provide design services and assist the Interior Designer with the development of non-proprietary performance criteria for the specialty equipment. Specialty equipment may require coordination with the Prime Contractor and subcontractors for connection of power, data, communications, waterlines, gases, etc. and calibration, testing and training prior to facility turnover and operation. The Equipment Specialist(s) must provide coordination of all necessary steps to provide a completely functional and operational facility at building turnover.

The Prime Contractor's Interior Designer and Equipment Specialist(s) are required to meet with the Activity to discuss the function of each area, validate all FF&E, CEQ and specialty equipment requirements, make any necessary changes and additions to the Concept FF&E package and recommend any adjustments/revisions to the interior building finishes and building infrastructure. The FF&E/CEQ effort includes the design, selection, specification, color coordination, procurement documentation and installation coordination of the equipment items necessary to meet the functional, operational, sustainability, and aesthetic needs of the facility. The FF&E/CEQ packages must be fully integrated with the design, construction, and schedule of all building finishes and all building systems (HVAC, Plumbing, Fire Protection, Communications, Electrical, Data, Architecture, etc.)

All electrical, data and communications outlets, switches, fire extinguishers, thermostats, sprinkler heads, etc. must be accommodated and be fully accessible once equipment is installed. ABA clearances must be accommodated. The Contractor's Interior Designer must work with the Prime Contractor and the electrical and telecommunication subcontractors to coordinate all infrastructure with the Recommended vendors. Dimensioned locations on plans and elevations for Multi-user Telecommunications Outlet Assemblies (MUTOAs), junction boxes, wall outlets and floor boxes, must be determined and provided by Contractor's Interior Designer, based on the sizes, layouts and configurations of the equipment items to be provided. See Section 1.6.2 Subsection g. If infrastructure planned for the building, such as power/data/communications requirements, must be revised to support the FF&E package, those revisions and coordination are the responsibility of the Contractor's Interior Designer and the Prime Contractor.

The FF&E plans must take into consideration any/all Collateral Equipment (CEQ) to include specialty equipment, existing and future Government-Furnished, Government Installed (GFGI) equipment and Government-Furnished, Contractor-Installed Equipment (GFCI). These items may include, but are not limited to: multi-function devices, printers, shredders, safes, vending machines, etc.

a. The Contractor's Interior Designer is responsible for incorporating new and existing CEQ into the FF&E plans.

b. The Activity will supply the Contractor's Interior Designer with a complete list of all existing and new CEQ, to include sizes, utility requirements, weight, etc., to be relocated or used in the new facility. The Contractor's Interior Designer has incorporated all necessary equipment into the FF&E plan.

These are minimum requirements and the Prime Contractor must be prepared to provide any/all additional meetings and submittals that may be necessary to support the Interior Design effort and FF&E coordination.

The Contractor's Interior Designer and equipment specialists are responsible for developing competitive and biddable Request for Proposal packages, with comprehensive, non-proprietary, technical performance criteria, as directed by the NAVFAC Interior Designer. Equipment must be biddable by at least three providers and the technical performance criteria must be based on product available through GSA Contract Vendors and other Federal contracts, in compliance with priorities found in FAR Part 8.404, when possible. If GSA Contract Vendors do not have access to the required equipment, research to find appropriate specialty equipment vendors may be required. Utilization of NAVFAC-provided templates is required for all Best Value Determination efforts and deliverables. The current NAVFAC standard templates are available at:

<http://www.wbdg.org/ffc/navy-navfac/collateral-equipment>

MIDLANT specific templates will be provided by the NAVFAC Interior Designer.

1.4 FF&E MEETINGS, PRESENTATIONS AND SUBMITTALS

The Prime Contractor's Interior Designer and the NAVFAC Interior Designer must attend all meetings, site visits and walk-throughs as required, obtain end-user and NAVFAC approvals and provide a complete and functional FF&E package. All meetings must be coordinated with advance notice to the NAVFAC Interior Designer, so that schedule and travel can be coordinated.

Each submittal must demonstrate thorough interaction with the Activity's functional requirements and complete coordination with the facility design and the Structural Interior Design (SID).

1.4.1 Interior Design Orientation Meeting

This meeting must occur at NAVFAC MIDLANT, located in Cherry Point, NC within 7 days of Pre-Construction/Kick-Off meeting, unless Contractor's Interior Designer approval is pending. If this meeting occurs at the Kick-Off Meeting, it must include a walk-through of the Activity's existing facility(s) or similar facilities. The NAVFAC Interior Designer will review the following with the Prime Contractor and the Contractor's Interior Designer: Schedule Development, Concept FF&E package, Best Value Determination (BVD) NAVFAC templates and process, Number of Best Value Determinations required, GSA or other mandatory sources to consider. A proposed preliminary schedule for the FF&E Meetings and Submittals must be submitted to the NAVFAC Interior Designer within 7 business days of this meeting. A final decision on the number of Best Value Determinations required may be dependent on the Prime Contractor's construction schedule and phasing. A minimum of three BVD's will be required for this project.

1.4.2 FF&E Concept Presentation Submittal and "Over the Shoulder" Review

Prior to the FF&E Concept Presentation to the Activity/End User, the Contractor's Interior Designer must present the FF&E Concept to the NAVFAC Interior Designer. If the Contractor's Interior Designer is remotely located, they can submit one hard copy of the presentation to the NAVFAC Interior Designer and schedule a follow-up discussion to review the presentation. If the Contractor's Interior Designer is local to the Norfolk, VA area, a meeting is required. The submittal can be presented in a "loose" format or binder (no presentation boards required) for NAVFAC approval prior to the Activity presentation. Catalog cut sheets and visuals from various manufacturers for each major FF&E item must be provided, along with cut sheets depicting commonly available options. Cut sheets should be clearly labeled with the item numbers used in the Concept FF&E package and FF&E plans. Information on durability and availability of finishes should be readily available for discussion. Fabric and finishes should not be discussed, except in terms of durability. The "over-the-shoulder" review meeting will be held at NAVFAC, located in Norfolk, VA or via conference call.

1.4.3 FF&E Concept Presentation to the Activity

After implementing all feedback from the NAVFAC FF&E Concept Presentation, the Prime Contractor's Interior Designer must present the NAVFAC approved Preliminary (Pre-final) FF&E package to the Activity, at a location determined by the Prime Contractor's ID and NAVFAC ID, for feedback and approval. This meeting must include a walk-through of the Activity's existing facility(s) or similar facility if this was not a part of the Kick-Off meeting. During this meeting, a detailed, functional review of the entire project must occur, with the proposed FF&E presentation to follow, to ensure that all current FF&E requirements have been captured. The presentation must include catalog cut sheets and visuals from various manufacturers for each major FF&E item, along with cut sheets depicting commonly available options. Cut sheets should be clearly labeled with the item numbers used in the FF&E plans. FF&E Presentation boards are not required. Minutes of this meeting with photos of the approved FF&E concept must be submitted to the NAVFAC Interior Designer within 7 business days.

1.4.4 Best Value Determination(BVD)Pricing Solicitation "Over the Shoulder Review"

After implementing all feedback from the FF&E Concept Presentation to the Activity, the Prime Contractor's Interior Designer will prepare a pricing solicitation package, using the provided NAVFAC templates, for use in soliciting FF&E pricing and determining a best value vendor. The Prime Contractor's Interior Designer must submit one electronic copy of the BVD Analysis Request for Pricing Cover Letter (live WORD document), one printed hard copy, in binder format, of the entire pricing solicitation package, and one book-marked, pdf format, electronic copy of the entire pricing solicitation package to the NAVFAC Interior Designer for an "over-the-shoulder" review. This submittal should be in the final, edited format that will be sent to the GSA Contract Vendors list. If the Prime Contractor intends to attach an example of their subcontract agreement to the package, a copy of the subcontract agreement must be included in this submittal. This submittal must be approved by NAVFAC prior to requesting pricing.

BVD Pricing Solicitation must include the following;

- a. BVD Analysis Request for Pricing cover letter:
The NAVFAC Cover Letter template must be used and highlighted areas must be edited, as required for the specific project. The electronic version of this submittal must include a "live" WORD document of the letter with all revisions indicated by "tracked changes". Information to clarify the scope can be added to the NAVFAC template provided; but no information should be deleted from the template without discussion with the NAVFAC Interior Designer.
 - 1. The Contractor's Interior Designer must coordinate a proposed FF&E "hold pricing" timeframe, up to 12 months, with the Prime Contractor, based on the construction schedule. The "hold pricing" timeframe must be requested in the BVD Analysis Request for Pricing cover letter. If a known price increase is expected, and vendor pricing cannot be held for the "hold pricing" timeframe requested, then the proposed vendor pricing must reflect the anticipated price increase(s). All anticipated price increases during the "pricing hold" period must be funded in the FF&E option. Manufacturer's documentation on the GSA price increase(s) and effective dates must be provided to NAVFAC.
- b. BVD Analysis Request for Pricing Spreadsheet/Questionnaire:
Item numbers must be updated to reflect all required FF&E items and tagged to coordinate with updated FF&E Plans. Spreadsheet info must include: Item Tag #, Basic Item Name/Brief Description, Basis of Design Manufacturer Name/Series/Product #, and a representative photo. Clear references to the applicable performance criteria should be provided below each item description.
- c. Performance Criteria:
Non-proprietary, technical, performance criteria must be created for each FF&E item, or each item category, to establish minimum acceptable FF&E requirements. Adequate level of detail must be provided so that comparable and competitive pricing can be obtained from at least three GSA Contract Vendors. Criteria must clearly reference the applicable FF&E item tags on the BVD Analysis Request for Pricing Spreadsheet and FF&E plans.
 - (1) Project Specific Workstation/Desk Typical:
Typicals for each item are required to include: a description, dimensioned plans with power, data and grommet locations, detailed elevations and isometric views, as necessary to communicate the desired layout. Typical must clearly reference the applicable FF&E item tags on the BVD Analysis Request for Pricing Spreadsheet and FF&E plans.
- d. Updated FF&E Plans:
FF&E Plans must be transferred to the Contractor's Interior Designer's title block with a legend coded to the updated FF&E item numbers used on the BVD Analysis Request for Pricing Spreadsheet. All Collateral equipment (CEQ), to include Audio Visual equipment, Government Furnished, Government Installed (GFGI) equipment such as printers and vending machines and Government Furnished, Contractor Installed (GFCI) equipment, must be indicated on drawings for coordination purposes.
- e. Copies of Electrical Power, Telecommunication, and A/V Plans and Details must be included in the package for coordination purposes.

1.4.5 BVD Vendor Recommendation and "Over the Shoulder Review"

The Prime Contractor's Interior Designer must submit one hard copy and one book-marked PDF copy of this submittal to the NAVFAC Interior Designer. Book-marked PDF copies must also be sent to the NAVFAC Construction Manager, the NAVFAC Contracting Officer, IDD/Base Property for Marine Corps Projects.

The Prime Contractor's Interior Designer must schedule an "Over the Shoulder" review conference call to review the results of the GSA Pricing Solicitation and discuss the best value vendor recommendation. The NAVFAC Contracting Officer must provide verbal approval of the GSA Contract Vendors recommendation during this call. If clarifications, updates or revisions are required, documentation must be revised and resubmitted. This submittal should include the following:

- a. Binder Cover Page/Spine Identification (Project name, Project #, Location, Submittal date, Submittal title)
- b. BVD Analysis Request for Pricing Spreadsheets/Questionnaires, as submitted by the three highest rated GSA Contract Vendors .
- c. Documentation showing that all required GSA Contract Vendors sources, in the appropriate SIN category were contacted (copy of the email solicitation).
- d. Bid Response from UNICOR, if received.
- e. Completed BVD Analysis Pricing Evaluation Spreadsheet, comparing ALL vendor pricing and responses in a side-by-side format. This spreadsheet must highlight proposed items that do not meet the required performance criteria, indicate specific proposal shortcomings, indicate the recommended GSA Contract Vendors , and highlight key factors supporting the best value GSA Contract Vendors recommendation. Open Market items and items that do not comply with the Buy America Act or Trade Agreement Act, must be indicated.
- f. Back-up information submitted by each bidder. (cut sheets/highlighted pricing sheets/technical specifications, pricing, dealer and manufacture qualifications for each product showing that product meets all requirements). Provide in cd format and include in the binder for the NAVFAC Interior Designer.
- g. A comprehensive written statement outlining the evaluation of each vendor's proposal and the key factors supporting the best value GSA Contract Vendors recommendation.

1.4.6 Vendor Recommendation Letter and De-Briefs

Following the approval of the GSA Contract Vendors recommendation, the Contractor's Interior Designer must send out notification to the GSA Contract Vendors who submitted pricing proposals and provide de-briefs to vendors, if requested. Templates for these notification letters and guidance for a standard de-brief will be provided by the NAVFAC Interior Designer.

1.4.7 Preliminary FF&E Presentation and Submittal

Once the best value vendor recommendation has been made, the Prime Contractor's Interior Designer must work in conjunction with the recommended vendor to develop the FF&E package that will be procured for the project. This package must be presented to the Activity and NAVFAC in loose format at a meeting to occur at Cherry Point, NC. Recommended FF&E finish and fabric samples for all major FF&E items should also be presented with large samples of the building interior finishes available for reference. All final product decisions, accessory additions and finish selections must be finalized at this meeting. Once Activity and NAVFAC feedback are implemented into the package, the Preliminary FF&E package must be submitted, in binder format, for review and comment.

Quantity of submittals required:

Provide one binder and one electronic copy each, for the NAVFAC Interior Designer, the Activity and for Base Property/IDD for Marine Corps projects. Provide electronic copies only for the Construction Manager and Contracting Officer.

The Preliminary FF&E Submittal must include the following:

- a. Binder Cover Page/Spine Identification (Project name, Project #, Location, Submittal date, Submittal title).
- b. Table of Contents and Identification Tabs for each section.
- c. Point of Contact List to include contact info for recommended GSA vendor(s), subcontractors and manufacturers.
- d. Preliminary FF&E Cost Summary to include shipping, freight, handling, professional installation, project management, HAR, SIOH and applicable sales tax. Cost summary template will be provided by the NAVFAC Interior Designer.
- e. Procurement Data "spec" Sheets for each product indicating item number, item manufacturer/series/product number, detailed item description, quantity, room location, general appearance, and proposed finish and fabric selections. Procurement Data Sheet template will be provided by NAVFAC Interior Designer. Creation of these Procurement Data Sheets is the responsibility of the Contractor's Interior Designer; not the GSA vendor or dealership. Item costs listed on Procurement Data Sheets must match costs on Cost Summary and costs on the Bill of Materials from each vendor.
- f. Updated FF&E Plans coded to the FF&E Cost Summary List and Procurement Data Sheets. All sizes and configurations of the FF&E to be provided should be reflected on these updated plans. All Collateral equipment (CEQ), to include Audio Visual equipment, Government Furnished, Government Installed (GFGI) equipment such as printers and vending machines and Government Furnished, Contractor Installed (GFCEI) equipment must be indicated on drawings for coordination purposes.
- g. FF&E Cost Comparison worksheet, listing all cost differences between bid pricing and final pricing, with justifications.
- h. Updated Electrical and Telecommunication Plans: Provide dimensioned locations on plans and elevations for Multi-user Telecommunications Outlet Assemblies (MUTOAs), junction boxes, wall

outlets and floor boxes, based on the sizes, layouts and configurations of the FF&E items to be provided.

i. Performance Criteria for all FF&E that was used in the BVD Pricing Solicitation.

j. Finish and fabric samples for all FF&E items attached to 8-1/2" x 11" mat boards and inserted into heavy duty plastic sheet protectors. All samples must have the manufacturer names and numbers listed and must reference the FF&E Item tags on the Procurement Data Sheets. Actual finish and fabric samples are required.

k. Copy of Manufacturer Bill of Materials (BOM) on manufacturer letterhead for each vendor. Bill of Materials must be coded to the FF&E Cost Summary Item codes. Sum of all manufacturer's Bill of Material totals must match Cost Summary totals exactly. All fees and taxes must be indicated on the BOM. If more than one Bill of Materials is provided, a summary list/spreadsheet listing all manufacturers and their BOM totals should be provided as a separate document.

l. Best Value Determination Guideline sheets; completed and signed by the Contractor's Interior Designer. Templates and guidance can be found at:

<http://www.wbdg.org/ffc/navy-navfac/collateral-equipment>

1.4.8 Final FF&E Submittal

The Final FF&E package must be submitted four months prior to the funding deadline (to be determined by funding source) and approved no later than nine months prior to the Contract Completion Date.

Once Activity and NAVFAC feedback are implemented into the package, the Final FF&E package must be submitted, in binder format, for review and approval.

Quantity of submittals required:

Provide one binder and one electronic copy each for the NAVFAC Interior Designer, the Activity, and for Base Property. Provide electronic copies only for the Contracting Officer and the Construction Manager.

The Final FF&E Submittal must include the following:

a. Binder Cover Page/Spine Identification (Project name, Project #, Location, Submittal date, Submittal title)

b. Table of Contents and Identification Tabs for each section.

c. Point of Contact List to include contact info for recommended GSA vendor(s), subcontractors and manufacturers.

d. Final FF&E Cost Summary to include shipping, freight, handling, professional installation, project management, HAR, SIOH and applicable sales tax. Cost summary template will be provided by the NAVFAC Interior Designer.

e. Final Procurement Data "spec" Sheets for each product indicating item number, item manufacturer/series/product number, detailed item description, quantity, room location, general appearance, and proposed

finish and fabric selections. Procurement Data Sheet template will be provided by NAVFAC Interior Designer. Creation of these Procurement Data Sheets is the responsibility of the Contractor's Interior Designer; not the GSA vendor or dealership. Item costs listed on Procurement Data Sheets must match costs on Cost Summary and costs on the Bill of Materials from each vendor.

f. Final updated FF&E Plans coded to the FF&E Cost Summary List and Procurement Data Sheets. All sizes and configurations of the FF&E to be provided should be reflected on these updated plans. All Collateral equipment (CEQ), to include Audio Visual equipment, Government Furnished, Government Installed (GFGI) equipment such as printers and vending machines and Government Furnished, Contractor Installed (GFCI) equipment must be indicated on drawings for coordination purposes.

g. FF&E Final Cost Comparison worksheet, listing all cost differences between bid pricing and final pricing with justifications.

h. Updated Electrical and Telecommunication Plans: Provide dimensioned locations on plans and elevations for Multi-user Telecommunications Outlet Assemblies (MUTOAs), junction boxes, wall outlets and floor boxes, based on the sizes, layouts and configurations of the FF&E items to be provided.

i. Performance Criteria for all FF&E that was used in the BVD Pricing Solicitation.

j. Finish and fabric samples for all FF&E items attached to 8-1/2" x 11" mat boards and inserted into heavy duty plastic sheet protectors. All samples must have the manufacturer names and numbers listed and must reference the FF&E Item tags on the Procurement Data Sheets. Actual finish and fabric samples are required.

k. Copy of Manufacturer Bill of Materials (BOM) on manufacturer letterhead for each vendor. Bill of Materials must be coded to the FF&E Cost Summary Item codes. Sum of all manufacturer's Bill of Material totals must match Cost Summary totals and Procurement Data sheets exactly.

l. Best Value Determination Guideline sheets; completed and signed by the Contractor's Interior Designer. Templates and guidance can be found at:

<http://www.wbdg.org/ffc/navy-navfac/collateral-equipment>

1.5 BEST VALUE DETERMINATION

A Best Value Determination (BVD) is required by FAR 8.404 when placing orders against Federal Supply Schedules for the selection of furniture and furnishings. Best Value is defined in FAR 2.101 as ensuring that the order to be placed under a Federal Supply Schedule results in the lowest overall cost alternative (considering price, special features, administrative costs and client's needs) to meet the government's needs.

- a. A (BVD) must be performed on a minimum of three manufacturers for orders exceeding a total procurement of \$10,000 from an individual manufacturer. Multiple BVDs may be required in order to complete the final FF&E package.

- b. The required quantity of BVD's to be performed will be determined by the NAVFAC Interior Designer and as necessary to support the construction schedule during the design phase and is dependent on the appropriate GSA Contract Vendors category(s) to be utilized and specific project requirements.
- c. Documentation must be provided to the Government with the final FF&E package. Specific Documentation is indicated in the BVD Vendor Recommendation and the Final FF&E Submittal. The Best Value Determination Guidelines form must be completed and signed by the Contractor's Interior Designer.

1.5.1 BVD Justifications

The Prime Contractor's Interior Designer is responsible for the following written BVD justifications:

For FF&E procurements with a value of \$10,000 or less, the Interior Designer may utilize any current GSA Contract Vendors. If none of the GSA Contract Vendors can supply the item, then any other manufacturer may be utilized.

For FF&E procurements with a value greater than \$10,000 and \$250,000 or less, the Prime Contractor's Interior Designer must always review published pricing from at least three current GSA Contract Vendors, in the applicable SIN Category and Region. In addition to the review of published list prices, the Contractor's Interior Designer must confirm the pricing with the vendor via a written quote. The BVD Guidelines Micro Purchase Threshold - Simplified Acquisition Threshold form must be completed and submitted for all FF&E procurements greater than \$10,000 and \$250,000 or less.

For FF&E procurements greater than \$250,000, GSA Contract Vendors in the applicable SIN Category and Region must always be solicited. The Prime Contractor's Interior Designer must develop a Request for Proposal pricing package complete with non-proprietary performance criteria and project requirements based on a generic design. This Request for Proposal must have adequate information for the GSA Contract Vendors to develop an FF&E price and performance proposal. The BVD Guidelines Greater than Simplified Acquisition Threshold form must be completed and submitted for all FF&E procurements greater than \$250,000 and manufacturer's quotes and a summary of all proposals must be attached.

1.5.2 Evaluation Factors

The Best Value Determination must address issues such as:

- a. Space planning; human factors data related to anthropometrics (reach, clearance, adjustability), space, and acoustics.
- b. Ergonomics.
- c. Product quality (including construction and materials); sustainability features, product warranties; history of the product and/or manufacturer.
- d. Ability to service products through dealers or others within a certain geographical range of the project.
- e. Price (including freight, design, project management and installation)

f. Aesthetics.

g. Appropriateness; lighting, power and telecommunications systems management and/or coordination as related to the facility (when applicable); and other project specific factors as identified and/or required.

h. The goal is to create a fully integrated design solution by providing quality FF&E products to meet the functional needs of the customer. Customer preferences must be considered. The focus must be on the best overall value. Use of the NAVFAC Best Value Determination form templates provided by the NAVFAC Interior Designer, is required.

1.5.3 UNICOR

Federal Prison Industries (UNICOR) must be considered as part of all BVDs. This must be done by sending an email with the requirements and evaluation criteria. If they are not comparable in one or more areas of price, quality, and time of delivery, the designer can specify product under **GSA Contract Vendors** schedule.

PART 2 FF&E TURNKEY EFFORT

2.1 FF&E OPTION

FF&E Option: As an option, provide procurement and installation coordination of the complete and usable Final FF&E package. The FF&E Package must include shipping, freight, handling, installation and the Prime Contractor's FF&E Handling and Administration Rate (HAR) percentage as applied to the final FF&E total cost and sales tax, if applicable.

2.1.1 Authorization

The Government will provide separate funding for procurement and installation coordination of the FF&E packages. Construction funds will not be used. Upon receipt of required funding, the Prime Contractor will be authorized by the Contracting Officer, as an option to the construction contract, to procure and install all Final FF&E utilizing, GSA Contract Vendors schedules, and other Federal contracts and complying with priorities found in FAR Part 8.404. The Prime Contractor will be expected to procure and coordinate the installation of the approved Final FF&E package exactly as specified, or NAVFAC approved equal. The amount of the modification will be the actual cost of these items from the Federal Government price schedules (GSA Contract Vendors), including any freight and installation charges from the furniture supplier as well as the Prime Contractor's Handling and Administration Rate (HAR) and any applicable state sales tax. The HAR must cover all of the Prime Contractor's effort related to storage, coordination, handling, administration of subcontractors, and all other associated costs and profit for the procurement of FF&E.

The Government will indicate the FF&E preliminary estimates based on the Concept Design in Spec Section 00 22 13 Supplementary Instructions to Bidders (Bid Schedule). These Government estimates must not be altered by Prime Contractors during the bid process. Prime Contractors must propose a HAR only. The Prime Contractor's proposed HAR may not exceed 5 percent of the total FF&E costs, as noted on the Supplementary Instructions to Bidders. The HAR must not include costs associated with the effort

required in Part 1.4 INTERIOR DESIGN SERVICES.

FF&E items are subject to the Buy American Act or Trade Agreement Act, unless they are considered COTS (Consumer Off The Shelf) items by the Contracting Officer.

2.1.2 Procurement and Installation and price Increases

The Prime Contractor and Contractor's Interior Designer must coordinate the building completion date with the installation dealer(s) specified in the FF&E Package and keep the NAVFAC Interior Designer updated on the status.

FF&E product should be ordered as soon as the option is awarded to avoid incurring additional costs for price increases. Delayed production and phased delivery dates can be coordinated with the installation dealer at the time of order placement, to coincide with the contract completion date.

The Prime Contractor must anticipate possible manufacturer price increases if order placement is delayed. Any costs incurred due to manufacturer price increases after the FF&E option will be the burden of the Prime Contractor. Any FF&E storage costs incurred due to construction delays and lack of communication with the installation dealer are the responsibility of the Prime Contractor.

2.1.3 GSA Schedules

The Prime Contractor must request a letter of authorization from the Contracting Officer citing the name of the furniture dealer(s) and authorization to access the Federal Government supply sources.

2.1.4 Deposits

The Prime Contractor must anticipate providing a deposit(s) of between 30 percent and 50 percent of the FF&E costs when placing the orders with the manufacturer's dealerships.

2.1.5 Davis Bacon Wages

Davis Bacon wages do not apply to the FF&E installer from the Government supply sources. The workforce for the FF&E installation and delivery must be separate and distinct from the labor workforce performing under the construction contract.

2.1.6 Sales Tax

The Prime Contractor must take maximum advantage of all exemptions from State and Local taxation authorities whether available to it directly or available to the Prime Contractor based on an exemption afforded the Government. The responsibility for paying applicable taxes rests with the Prime Contractor. Any state and local taxes applicable to the FF&E must be included within the FF&E Dealer's quote and funded in the FF&E option. Any items purchased as building materials, such as carpet, are taxable.

2.1.7 Bonds

FF&E items are not considered construction and the Prime Contractor is not required by the Government to secure any additional bonds for the award of the FF&E line item, unless otherwise indicated in the contract. If any additional bond is required for the FF&E line item it is to be included in

the Prime Contractor's FF&E HAR.

2.1.8 Unique Item Identification (IUID) and Valuation

Unique item identification and valuation is a system of marking and valuing items delivered to DoD that enhances logistics, contracting, and financial business transactions. The IUID policy is mandatory for all DoD contracts that require the delivery of items. An item is a single article or a single unit formed by a grouping of subassemblies, components, or constituent parts. The Prime Contractor must provide DoD Unique item identification, valuation and delivery of data for all required FF&E items for which the government's unit acquisition cost is \$5,000 or more. This information must be provided in the Ordering Documentation referenced in Section 3.3 at the final FF&E punch list site visit.

PART 3 EXECUTION

3.1 Installation

The FF&E package includes the installation of all furniture and furnishings as specified in the FF&E package. The installation dealer(s) specified in the FF&E package shall receive, store as required, transport to the project site, off load, inside deliver, unpack, assemble, place/install, clean, and dispose of all the trash for all furniture and furnishings. It is the Prime Contractor's responsibility to coordinate the building completion, occupancy, and furniture installation dates with the installation dealer(s) specified in the FF&E package. Any costs associated with or delaying furniture shipments is the responsibility of the Prime Contractor.

The Prime Contractor shall provide and coordinate all Building Systems (HVAC, Plumbing, Fire Protection, Communications, Electrical, Data, Architectural, etc. with the furniture plans and furniture installation. All outlets, switches, thermostats, etc. shall be fully accessible. All sprinkler heads, fire extinguishers, ADA, etc., clearances shall be accommodated.

3.2 Installation Warranty

All FF&E must be installed in accordance with the manufacturer's instructions and warranty requirements. All FF&E must be leveled and aligned. All doors, drawers and accessories must be leveled and aligned to open, close and otherwise operate smoothly and securely.

All FF&E must be installed by the furniture manufacturer's dealer of record and not the Prime Contractor. The Government reserves the right to approve/disapprove the Prime Contractor's FF&E installers. In addition, dealer, teaming partners and installation team(s) must be located within a 250 mile radius of the project site, unless approved by the NAVFAC Interior Designer. The Prime Contractor must repair, to the Government's satisfaction, any/all damage to any facility finish that is a result of the furniture installation and correct all punch list items for the FF&E. The Prime Contractor must obtain services of equipment specialists to install the electrical equipment, to include but not limited to televisions, Video Teleconference Equipment, ceiling mounted projectors, and mission essential electronic equipment included in the FF&E package.

3.3 Ordering Documentation

After award of the FF&E package, three CD copies and one binder copy for

Marine Corps projects of all ordering documentation, including Factory Order number (FO) and warranty information for all products, shall be provided to the Contracting Officer at the final FF&E walk-thru.

3.4 Post Award Changes

The Government requires the Prime Contractor to provide FF&E items exactly as specified in the Final FF&E submittals and as awarded in the FF&E option. Should changes become necessary, careful consideration is essential to assure that equivalent quality, price and functionality of the item are maintained. Coordination with building finishes and other FF&E items is required for all proposed substitutions. Information on specific item type, quality, color, finish, fabric, price, sustainability, life cycle, and dealership service must be provided to the NAVFAC Interior Designer for item approval. After award of the FF&E option, any request to change the FF&E items which affects the price of the item must be negotiated and may not be funded. The Prime Contractor must obtain approval from the NAVFAC Interior Designer and the Contracting Officer for any changes to the FF&E Package.

Post award FF&E manufacturer's price increases, beyond the "hold pricing" date, are the responsibility of the Prime Contractor and must not be transferred to the Government.

3.5 Punch List

The Contractor, his Interior Designer (and other specialty consultants, if applicable) must attend at least two punch list site visits with the installation dealer(s), NAVFAC Interior Designer and the Base Representative/Activity Contact. The first site visit must identify all punch list items (at installation dealer's 98 percent completion) and the second (at 100 percent completion) will confirm that all punch list items have been resolved.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 31 50

TRANSFER AND ACCEPTANCE OF MILITARY REAL PROPERTY

07/21

PART 1 GENERAL

1.1 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-11 Closeout Submittals

Interim DD-1354, Transfer & Acceptance of Military Real Property

1.2 Interim DD-1354, Transfer & Acceptance of Military Real Property

Submit Interim DD-1354 thirty (30) days prior to beneficial occupancy date
(draft copy attached).

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 32 16

CONSTRUCTION PROGRESS DOCUMENTATION

07/21

PART 1 GENERAL

1.1 SUBMITTALS

Submit the following in accordance with Section 01 33 00, "Submittal Procedures."

SD-01 Preconstruction Submittals

Construction schedule

Equipment delivery schedule

1.2 CONSTRUCTION SCHEDULE

Within 21 days after receipt of the Notice of Award, prepare and submit to the Contracting Officer for approval a Critical Path Method (CPM), Network Schedule in accordance with the terms in Contract Clause "FAR 52.236-15, Schedules for Construction Contracts," except as modified in this contract. Primavera P6 will be utilized to produce and update all progress schedules.

1.2.1 HVAC TAB Milestones

Requirements for the milestones related to HVAC TAB work, SECTION 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC are specified in Section 01 20 00, "Price and Payment Procedures."

1.3 EQUIPMENT DELIVERY SCHEDULE

1.3.1 Initial Schedule

Within 30 calendar days after approval of the proposed construction schedule, submit for Contracting Officer approval a schedule showing procurement plans for materials, plant, and equipment. Submit in the format and content as prescribed by the Contracting Officer, and include as a minimum the following information:

- a. Description.
- b. Date of the purchase order.
- c. Promised shipping date.
- d. Name of the manufacturer or supplier.
- e. Date delivery is expected.
- f. Date the material or equipment is required, according to the current construction schedule.

1.4 NETWORK ANALYSIS SYSTEM (NAS)

The Contractor shall use the critical path method (CPM) to schedule and control construction activities. The Network shall have a minimum of 25 activities and a maximum of 50 activities. The schedule shall identify as a minimum:

- a. Construction time for all major systems and components;
- b. Major submittals and submittal processing time; and
- c. Major equipment lead time.

1.4.1 CPM Submittals and Procedures

The Contractor shall use the critical path method (CPM) to schedule and control project activities. Project schedules shall be prepared and maintained using Primavera P6, Primavera SureTrak or current mandated scheduling program. Save files in Concentric P6 or current mandated scheduling program file format, compatible with the Governments version of the scheduling program. The network analysis system shall be kept current, with changes made to reflect the actual progress and status of the construction.

1.5 UPDATED SCHEDULES

Update the construction schedule and equipment delivery schedule at monthly intervals or when schedule has been revised. Reflect any changes occurring since the last update. Submit copies of the purchase orders and confirmation of the delivery dates as directed.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 32 17.00 20

COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS)
05/18, CHG 3: 08/20

PART 1 GENERAL

1.1 DEFINITIONS

The cost-loaded Network Analysis Schedule (NAS) is a tool to manage the project, both for Contractor and Government activities. The NAS is also used to report progress, evaluate time extensions, and provide the basis for progress payments.

For consistency, when scheduling software terminology is used in this section, the terms in Primavera's scheduling programs are used.

1.2 SCHEDULE REQUIREMENTS PRIOR TO THE START OF WORK

1.2.1 Preliminary Scheduling Meeting

Before preparation of the Project Baseline Schedule, and prior to the start of work, meet with the Contracting Officer to discuss the proposed schedule and the requirements of this section. Propose projected data dates for monthly update schedules for the project and incorporate each monthly update submittal into submittal register. Discuss required forms, terminology, and submittal requirements of this section and other requirements related to schedule management for this contract.

1.2.2 Project Baseline Schedule

Submit the Baseline NAS within 45 calendar days after contract award. Data date must be set to contract award date and no progress status for any activity. Only bonds may be paid prior to acceptance of the Baseline NAS. The acceptance of a Baseline NAS is a condition precedent to:

- a. The Contractor starting demolition work or construction stage(s) of the contract.
- b. Processing Contractor's invoices(s) for any items other than bonds.
- c. Review of any schedule updates.

Submittal of the Baseline NAS is the Contractor's certification that the submitted schedule meets the requirements of the Contract Documents and represents the Contractor's plan on how the work will be accomplished. Provide all items listed in paragraph REQUIRED TABULAR REPORTS AND NATIVE P6 XER FILES with baseline NAS submittal.

1.3 THREE-WEEK LOOK AHEAD SCHEDULE

1.3.1 Weekly CQC Coordination and Production Meeting

Deliver electronic file of 3-Week Look Ahead Schedule to the Contracting Office at least 24 hours prior to the weekly scheduled CQC Coordination and Production Meeting. Contractor is required to provide all attendees at the CQC Coordination and Production Meeting with a hard copy of the 3-Week Look Ahead Schedule.

1.3.2 Look Ahead Schedule Requirements

Prepare and issue a 3-Week Look Ahead schedule to provide a more detailed day-to-day plan of upcoming work identified on the Project Network Analysis Schedule. Requirements include:

- a. For each Look Ahead schedule activity, identify parent NAS activity number(s). The parent NAS activity is the activity in the NAS that would incorporate the Look Ahead schedule activity requirement and or scope of work.
- b. Update schedule each week to show the planned work for the current and following two-week period. Also include previous week, as-built work, showing actual start and finish dates.
- c. Include upcoming outages, closures, preparatory meetings, and initial meetings, testing and inspections.
- d. Clearly identify longest path activities on the Three-Week Look Ahead Schedule. Include a key or legend that distinguishes longest path activities. Include all Longest Path activity NAS start/finish dates exceeded and/or occurring during this period.
- e. The detail work plans are to be bar chart type schedules, derived from but maintained separately from the Project NAS on an electronic spreadsheet program and printed on 11 by 17 inch sheets as directed by the Contracting Officer.
- f. Activities must not exceed 5 working days in duration and have sufficient level of detail to assign crews, tools and equipment required to complete the work.

1.4 MONTHLY NETWORK ANALYSIS

Submittal of Monthly NAS is the Contractor's certification that the submitted schedule meets the requirements of the Contract Documents and represents the Contractor's plan on how the work will be accomplished. Provide all items listed in paragraph REQUIRED TABULAR REPORTS AND NATIVE P6 XER FILES with the monthly NAS submittal.

1.4.1 Monthly Network Analysis Updates

- a. Regardless of whether an invoice is being submitted monthly, an updated schedule must be submitted monthly to the Government. The Monthly NAS update must be submitted within 10 calendar days of the data date.
- b. Provide all items listed in paragraph REQUIRED TABULAR REPORTS AND NATIVE P6 XER FILES, with each monthly NAS update submittal.
- c. Meet with Government representative(s) at monthly intervals to review and agree on the information presented in the updated project schedule. The submission of an accepted, updated schedule to the Government is a condition precedent to the processing of the Contractor's invoice.
- d. Activity progress must incorporate as-built events as they occurred and correspond to records including but not limited to submittals and

daily production and quality control reports. Software Settings: Handle schedule calculations and Out-of-Sequence progress (if applicable) through Retained Logic, not Progress Override. Show all activity durations and float values in days. Show activity progress using Remaining Duration. Set default activity type to "Task Dependent".

- e. Update schedule must reflect current Contract Completion Date and contract value in accordance with all conformed contract modifications issued prior to data date of NAS update.

1.4.2 As-Built Schedule

As a condition precedent to the release of retention and making final payment, submit an "As-Built Schedule," as the last schedule update showing all activities at 100 percent completion. This schedule must reflect the exact manner in which the project was actually constructed.

1.5 CORRESPONDENCE AND TEST REPORTS

Reference Schedule activity IDs that are being addressed in each correspondence (e.g., letters, Requests for Information (RFIs), e-mails, meeting minute items, Production and QC Daily Reports, material delivery tickets, photographs) and test report (e.g., concrete, soil compaction, weld, pressure).

1.6 ADDITIONAL SCHEDULING REQUIREMENTS

Other specification sections may include additional scheduling requirements, including systems to be inspected, tested and commissioned, and submittal procedures. Those schedule requirements must be incorporated into the NAS schedule.

1.7 SUBMITTALS

Government approval/acceptance is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Baseline NAS; G

Designated Project Scheduler; G

SD-07 Certificates

Three-Week Look Ahead Schedule; G

Monthly Network Analysis Updates; G

SD-11 Closeout Submittals

As-Built Schedule; G

1.8 SOFTWARE

Prepare and maintain project schedules using Primavera P6 software in a version compatible with Government's current version. Importing data into P6 using data conversion techniques or third party software is cause for rejection of the submitted schedule. Schedules with Performing Organizational Breakdown Structure (POBS) data is cause for rejection.

1.9 DESIGNATED PROJECT SCHEDULER

Within 30 calendar days of contract award, submit to the Contracting Officer for approval an individual who will serve as the Designated Project Scheduler. Include a copy of the candidate's resume with qualifications. The Contracting Officer may remove the Designated Project Scheduler, and require replacement, if the scheduler does not effectively fulfill their duties in accordance with the contract requirements. Payment request will not be processed without an approved Designated Project Scheduler.

1.9.1 Qualifications

The Designated Project Scheduler must have prepared and maintained at least three previous construction schedules, of similar size and complexity to this contract, using Primavera P6.

1.9.2 Duties

Duties of the Designated Project Scheduler:

- a. Prepare Baseline NAS.
- b. Prepare monthly schedule updates.
- c. Prepare tabular reports.
- d. Prepare Time Impact Analysis (TIA) as necessary.
- e. Provide certification that NAS and TIA submittals conform to the contract requirements.
- f. Participate with the Prime Contractor and Government Representative in a monthly meeting and scheduled with sufficient time to support the Monthly Network Analysis Updates process, to discuss project status, schedule updates, critical activities, potential delays, and contract modifications impacting the schedule. Have a computer with P6 software available during the meeting.

1.10 NETWORK SYSTEM FORMAT

Prepare the schedule in accordance with the following Primavera P6 settings and parameters. Deviation from these settings and parameters, without prior consent of the Contracting Officer, is cause for rejection of schedule submission.

1.10.1 Schedule Activity Properties and Level of Detail

1.10.1.1 Activity Identification and Organization

- a. Identify construction activities planned for the project and other

activities that could impact project completion if delayed in the NAS.

- b. Each activity must have a unique name.
- c. Identify administrative type activity/milestones, including all pre-construction submittal and permit requirements prior to demolition or construction stage.
- d. Include times for procurement, Contractor quality control and construction, acceptance testing and training in the schedule.
- e. Include the Government approval time required for the submittals that require Government Approval prior to construction, as indicated in [Section 01 33 00 SUBMITTAL PROCEDURES](#).
- f. Create separate activities for each Phase, Area, Floor Level and Location the activity is occurring.
- g. Do not use construction category activity to represent non-work type reference (e.g. Serial Letter, Request for Information) in NAS. Place Non-work reference within the P6 activity details notebook.

Activity categories included in the schedule are specified below.

1.10.1.2 Activity Logic

- a. With the exception of the Contract Award and Contract Completion Date (CCD) milestone activities, activity must not be open-ended; each activity must have at least one predecessor and at least one successor.
- b. Activities must not have open start or open finish (dangling) logic.
- c. Do not use lead or lag logic without Contracting Officer prior approval.
- d. Minimize redundant logic ties.
- e. Once an activity exists on the schedule it must not be deleted or renamed to change the scope of the activity and must not be removed from the schedule logic without approval from the Contracting Officer.
 - (1) While an activity cannot be deleted, where said activity is no longer applicable to the schedule, but must remain within the logic stream for historical record, change the activity original and remaining duration to zero and clearly label "(NO LONGER REQUIRED)" after the activity name. Actual finish date for activity that falls behind the data date. Redistribute accordingly any remaining budget associated with that activity, to other remaining appropriate activity.
 - (2) Document any such change in the activities' "Notebook," including a date and explanation for the change.
 - (3) The ID number for a "NO LONGER REQUIRED" activity must not be re-used for another activity.

1.10.1.3 Longest Path Activity Baseline Limitation

For P6 settings, critical activities are defined as being on the Longest

Path. Longest Path (Critical) Activities must not make up more than 30 percent of all activity within the Construction Baseline Schedule.

1.10.1.4 Assigned Calendars

All NAS activity must be assigned calendars that reflect required and anticipated non-work days.

1.10.1.5 Activity Categories

1.10.1.5.1 Pre-construction Activities

Examples of pre-construction activities include, but are not limited to, bond approval, permits, pre-construction submittals and approvals. Include pre-construction activities that are required to be completed prior to the Contractor starting the demolition or construction stage of work.

1.10.1.5.2 Procurement Activities

Examples of procurement activities include, but are not limited to: Material/equipment submittal preparation, submittal and approval of material/equipment; material/equipment fabrication and delivery, and material/equipment on-site. As a minimum, separate procurement activities must be provided for critical items, long lead items, items requiring Government approval and material/equipment procurement for which payment will be requested in advance of installation. Show each delivery with relationship tie to the Construction Activity specifically for the delivery.

1.10.1.5.3 Government Activities

Government and other agency activities that could impact progress must be clearly identified. Government activities include, but are not limited to; Government approved submittal reviews, Government conducted inspections/tests, environmental permit approvals by State regulators, utility outages, and delivery of Government Furnished Material/Equipment.

1.10.1.5.4 Construction Quality Management (CQM) Activities

The Preparatory and Initial Phase meetings for each Definable Feature of Work identified in the Contractor's Quality Control Plan must be included in the Three-Week Look Ahead Schedule. Preparatory and Initial phase meetings are not required in the NAS, but can be represented by a start milestone linked to successor parent Construction Activity. The Follow-up Phase must be represented by the Construction Activities themselves in the NAS.

1.10.1.5.5 Construction Activities

On-site construction activities must not have a duration in excess of 20 working days. Contractor activities must be driven by calendars that reflect Saturdays, Sundays and all Federal Holidays as non-work days, unless otherwise defined in this contract. [Federal Holidays are as defined in 5 USC 6103.](#)

1.10.1.5.6 Turnover and Closeout Activities

Include activities or milestones for items on the NAVFAC Red Zone

Checklist/POAM that are applicable to this project. As a minimum, include required Contractor testing, required Government acceptance inspections on equipment, Pre-Final Inspection, Punch List Completion, Final Inspection and Acceptance. Add an unconstrained start milestone for the initial NAVFAC Red Zone - Facility Turnover Planning Meeting at approximately 75 percent construction contract completion or six months prior to Contract Completion Date (CCD), whichever is sooner.

1.10.1.6 Contract Milestones and Constraints

1.10.1.6.1 Project Start Date Milestones

Include as the first activity on the schedule a start milestone titled, "Contract Award", which must have a Mandatory Start constraint equal to the Contract Award Date.

1.10.1.6.1.1 Post-Award Kickoff (PAK) meeting Milestone

Include an unconstrained finish milestone on the schedule titled, "Post-Award Kickoff Meeting". The Post Award Kickoff Meeting may be a single day, or it may range over several days. The intent is to cover all PAK topics, including Partnering and Concept Design Workshop (if required) in one continuous session.

1.10.1.6.2 Pre-Construction Meeting Milestone

Include an unconstrained finish milestone on the schedule titled, "Pre-Construction Meeting". The Pre-Construction meeting may be a single day, or it may range over several days. The intent to cover all the Pre-Con topics, including Partnering and DD1354.

1.10.1.6.3 Preconstruction Submittals Finish Milestone

Include an unconstrained finish milestone on the schedule titled, "Preconstruction Submittals". This milestone is complete when all required preconstruction submittals have been reviewed and approved by the Government.

1.10.1.6.4 Contractor Mobilization Finish Milestone

Include an unconstrained finish milestone on the schedule titled, "Contractor Mobilization".

1.10.1.6.5 NAVFAC Red Zone - Facility Turnover Planning Meeting Milestones

See paragraph TURNOVER AND CLOSEOUT ACTIVITIES above.

1.10.1.6.6 Substantial Completion Milestone

Include an unconstrained finish milestone on the schedule titled "Substantial Completion." Substantial Completion is defined as the point in time the Government would consider the project ready for beneficial occupancy wherein by mutual agreement of the Government and Contractor, Government use of the facility is allowed while construction access continues in order to complete remaining items (e.g. punch list and other close out submittals). Include a separate Substantial Completion Milestone for each phase if the contract requires construction to be completed in phases.

1.10.1.6.7 DD-1354 Finish Milestone

Add unconstrained finish milestone, titled "DD-1354" and scheduled 30 calendar days prior to Substantial Completion, whenever a Form DD-1354 is required in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS.

1.10.1.6.8 Projected Completion Milestone

Include an unconstrained finish milestone on the schedule titled "Projected Completion." Projected Completion is defined as the point in time all contract requirements are complete and verified by the Government with a successful Final Inspection in accordance with Section 01 45 00.00 20 QUALITY CONTROL. This milestone must have the Contract Completion Date (CCD) milestone as its only successor.

1.10.1.6.9 Contract Completion Date (CCD) Milestone

Last schedule entry must be an unconstrained finish milestone titled "Contract Completion (CCD: DD-MM-YY)." DD-MM-YYYY is the current contract completion date at data date, day-month-year corresponding to P6 Must Finish By Date. NAS milestone updates of Project Completion finish date for longest path must reflect calculated float as positive or negative based on CCD. Calculation of schedule updates must be such that if the finish of the "Projected Completion" milestone falls after the contract completion date, then negative float is calculated on the longest path. If the finish of the "Projected Completion" milestone falls before the contract completion date, the float calculation must reflect positive float on the longest path.

1.10.1.6.10 Additional Milestones

Provide up to 5 additional milestones as required by Contracting Officer.

1.10.1.7 Work Breakdown Structure & Activity Code

At a minimum, establish a Work Breakdown Structure (WBS) and provide activity codes identified as follows:

1.10.1.7.1 Work Breakdown Structure (WBS)

Group all activities and milestones within appropriate WBS categories including, at a minimum, the following:

a. Project Milestones:

- (1) Management Milestones
- (2) Project Administrative Meetings
- (3) Permits

b. Pre-Construction Phase:

- (1) Submittals and Reviews
- (2) Procurement
- (3) Mobilization

- c. Construction Phase: Create multiple sub-sections in accordance with project specific categories of work including in WBS descending order as follows:

- (1) General Area

- (a) Type of Work Item

- 1. Location

- d. Project Closeout: Include activity items such as, but not limited to, Punchlist, Demobilization, O&M, As-built Drawings, Training, and As-built NAS.
 - e. Modifications: Create sub-category of Conformed and Non-Conformed under Modification WBS. Create multiple sub-sections as the project progresses identified by issue and Fragnet placed in Conformed for modifications issued prior data date, or Non-Conformed for issues not modified to contract prior data date.
 - f. Removed Activity: Activity is "removed" by remaining within logic sequence, eliminating duration and adding "(NO LONGER REQUIRED)" after Activity Name in Activity Table.

1.10.1.7.2 Responsibility Code

All activities in the project schedule must be identified with the resource for completing the task. Activities must not belong to more than one responsible party.

1.10.1.7.3 Activity Category Code

Provide user defined "CAT" codes for Project Level activity codes. Use the following codes:

- a. Assign "PROC" value to Procurement type activity
- b. Assign "PRE-CON" value to Pre-construction activity
- c. Assign "CONS" value to Construction type activity
- d. Assign "TEST" value to dedicated testing type activities
- e. Assign "CX" value to dedicated Commissioning type activities
- f. Assign "CLOS" value to dedicated Close Out type activity
- g. Assign "OTHR" to other activity not otherwise designated

1.10.1.8 Adverse Weather Lost Work Days

Assign the Weather Calendar to any activity that could be impacted by adverse weather. The Contracting Officer will issue a modification in accordance with the contract clauses, giving the Contractor a time only extension for the difference of days between the anticipated and actual adverse weather delay if the number of actual adverse weather delay days exceeds the number of days anticipated for the month in which the delay occurs and the adverse weather delayed activities are on the longest path to contract completion in the period when delay occurred. A lost workday

due to weather conditions is defined as a day in which the Contractor cannot work at least 50 percent of the day on the impacted activity. Impacts resulting from adverse weather must be documented in Narrative Report for the month that it occurred.

Make changes to P6 project calendars to reflect as-built conditions where work occurred where originally anticipated as non-work days, and where work did not occur (lost work day).

1.10.1.9 Cost Loading

The Project Network Analysis Schedule (NAS) must be cost-loaded and will provide the basis for progress payments. Earned Value Reports must be derived from and correspond to cost loaded NAS. Use the Critical Path Method (CPM) and the Precedence Diagram Method (PDM) to satisfy time and cost applications.

1.10.1.9.1 Cost Loading Activities

Assign material and equipment costs, including their quantities, for which payment will be requested in advance of installation, to their respective procurement activity. Assign labor costs, including their quantities, for material and equipment paid for after installation to their respective construction activities. Include all typical mobilization costs dispersed over early construction activities. Costs for mobilization will not be paid as individual pay items with the exception of batch plant set-up, mobilization of dredging equipment or other similar labor-intensive situations. The value of commissioning, testing and closeout WBS section may not be less than 10 percent of the total costs for procurement and construction activities. ALL activities assigned Government responsibility will have Zero Cost. No contractor cost should be assigned to an activity designated as a Government responsibility. Do not include field overhead positions as individual pay items. Evenly disperse overhead costs and profit to each activity over the duration of the project.

1.10.1.9.2 Partial Payment

Breakdown unit of measure and cost must be defined within P6 Activity Detail Expenses for partial payment of any cost loaded activity. Lump sum cost loaded activity will not be partially paid.

1.10.2 Schedule Software Settings and Restrictions

- a. Activity Constraints: Date/time constraint(s), other than those required by the contract, are not allowed unless accepted by the Contracting Officer. Identify any constraints proposed and provide an explanation for the purpose of the constraint in the Narrative Report as described in paragraph REQUIRED TABULAR REPORTS.
- b. Default Progress Data Disallowed: Actual Start is date work begins on activity with intent to pursue work to substantial completion. Actual Finish is date work is substantially complete to point where successor activity can begin. Actual dates on the CPM schedule must correspond with activity dates reported on the Contractor Quality Control and Production Reports.
- c. At a minimum, include the following settings and parameters in P6 Schedule preparation:

- (1) General: Define or establish Calendars and Activity Codes at the "Project" level, not the "Global" level.
- (2) Admin Drop-Down Menu, Admin Preferences, Time Periods Tab:
 - (a) Set time periods for P6 to 8.0 Hours/Day, 40.0 Hours/Week, 172.0 Hours/Month and 2000.0 Hours/Year.
 - (b) Use assigned calendar to specify the number of work hours for each time period: Must be checked.
- (3) Admin Drop-Down Menu, Admin Preferences, Earned Value Tab:
 - (a) Earned Value Calculation: Use "Budgeted values with current dates".
- (4) Project Level, Dates Tab:
 - (a) Set "Must Finish By" date to "Contract Completion Date", and set "Must Finish By" time to 05:00pm.
- (5) Project Level, Defaults Tab:
 - (a) Duration Type: Set to "Fixed Duration & Units".
 - (b) Percent Complete Type: Set to "Physical".
 - (c) Activity Type: Set to "Task Dependent".
 - (d) Calendar: Set to "Standard 5 Day Workweek". Calendar must reflect Saturday, Sunday and all Federal holidays as non-work days. Alternative calendars may be used with Contracting Officer approval.
- (6) Project Level, Calculations Tab:
 - (a) Default Price/Unit for activities without resource or role Price/Units: Set to "\$1/h".
 - (b) Activity percent complete based on activity steps: Must be Checked.
 - (c) Link Budget and At Completion for not started activities: Must be Checked.
 - (d) Reset Remaining Duration and Units to Original: Must be Selected.
 - (e) Subtract Actual from At Completion: Must be Selected.
 - (f) Recalculate Actual units and Cost when duration percent complete changes: Must be Checked.
 - (g) Update units when costs change on resource assignments: Must be Unchecked.
 - (h) Link Actual to Date and Actual This Period Units and Cost: Must be Checked.

(7) Project Level, Settings Tab:

(a) Define Critical Activities: Check "Longest Path".

(8) Work Breakdown Structure Level, Earned Value Tab:

(a) Technique for Computing Performance Percent Complete:
"Activity percent complete" is selected.

(b) Technique for Computing Estimate to Complete (ETC): "PF = 1"
is selected.

1.10.3 Required Tabular Reports and Native P6 XER Files

Include the following reports with the Baseline, Monthly Update and any other required schedule submittals:

a. Time Scaled Logic Schedule

Provide formatted 11 by 17-inch Time-scaled Logic Schedule in color and landscape-oriented with each schedule submittal. Clearly show activities on the longest path setting Gantt chart longest path activity bars to red. Group activities by WBS and sort by finish date in ascending order. Include the following information in column form for each activity and include accompanying Gantt chart:

- (1) Activity ID
- (2) Activity Name
- (3) Original Duration
- (4) Remaining duration
- (5) Physical Percent Complete
- (6) Start Date
- (7) Finish Date
- (8) Total Float

b. Previous Monthly Update Comparison Time Scaled Logic Schedule (Submit with all Monthly Update Schedule Submittals.)

Provide formatted 11 by 17-inch Time-scaled Logic Schedule in color and landscape-oriented with each monthly update schedule submittal. Clearly show activities on the current month longest path setting Gantt chart longest path activities bars to red. Show previous month activities as yellow bars and previous month milestones in yellow within Gantt chart. Sort by finish date in ascending order. Filter activities for longest path. Maintain and assign the accepted previous month update or the accepted baseline schedule for the first update submittal as the baseline and primary baseline in P6 before printing the schedule. Include the following information in column form for each activity and include accompanying Gantt chart:

- (1) Activity ID

- (2) Activity Name
 - (3) Original Duration
 - (4) Current Month Remaining Duration
 - (5) Current Month Start Date
 - (6) Previous Month Update Start Date (BL Project Start)
 - (7) Start Date Delta between Current Month and Previous Month
(Variance - BL Project Start Date)
 - (8) Current Month Finish Date
 - (9) Previous Month Finish Date (BL Project Finish)
 - (10) Finish Date Delta between Current Month and Previous Month
(Variance - BL Project Start Date)
 - (11) Current Month Total Float
- c. P6 native XER file: Include the back-up native .xer program file compatible with the Government version of P6. Each native schedule file must have a unique file name to include project name and data date using (yyyy-mm-dd) convention. Each native schedule must have a unique Project ID and Project Name.
- d. Log Report: P6 Scheduling/Leveling Report.
- e. Narrative Report: Identify and justify:
- (1) Provide Project Summary Data in format below:
 - (a) Data Date _____
 - (b) Award Date: _____
 - (c) Original Project Duration: _____ days post Award Date
 - (d) Current Project Duration: _____ days post Award Date
 - (e) Time percent elapsed: _____ percent at data date
 - (f) Original CCD: _____
 - (g) Current CCD: _____ (thru MOD _____)
 - (h) Anticipated CCD: _____ (____ calendar days early/late)
 - (i) Original Contract Value: \$_____
 - (j) Current Contract Value: \$_____
 - (k) Invoiced Amount: \$_____ (____ percent)
 - (l) Cost Growth: _____ percent

- (m) Schedule Growth: ____ percent
- (n) There are a total of ____ activities, ____ activities complete (____ percent), ____ activities in progress (____ percent), ____ activities not started (____ percent). Of the in progress and not started activities; ____ (____ percent) are on the longest path. The longest path has duration of ____ calendar days from data-date to anticipated project completion.
- (2) Progress made in each area of the project;
- (3) Longest Path;
- (4) Date/time constraint(s), other than those required by the contract
- (5) Listing of all changes made between the previous schedule and current updated schedule include: added or deleted activities, original and remaining durations for activities that have not started, logic (sequence constraint lag/lead), milestones, planned sequence of operations, longest path, calendars or calendar assignments, and cost loading;
- (6) Any decrease in previously reported activity Earned Amount;
- (7) Pending items and status thereof, including permits, changes orders, and time extensions;
- (8) Status of Contract Completion Date and interim milestones;
- (9) Status of Projected Completion Milestone and account of difference in calendar days between previous update Projected Completion Milestone
- (10) Current and anticipated delays listing Activity Names and IDs for impacted activities(describe cause of delay and corrective actions(s) and mitigation measures to minimize);
- (11) Description of current and potential future schedule problem areas.
- (12) Identification of any weather and restricted lost time as compared to anticipated weather for the month and anticipated restricted days for which the update is submitted. Impacts resulting from adverse weather must be documented in tabular form showing the calendar month (or billing period) with the days on which construction activity incurred Lost Work Days due to adverse weather. In narrative form, describe the adverse weather cause such as precipitation measurement, temperature, wind or other influencing factors, and why work was impacted. Describe the construction activity(s) that was (were) scheduled, impacted.

Each entry in the narrative report must cite the respective Activity ID and Activity Name, the date and reason for the change, and description of the change.

- f. Earned Value Report: Derive from and correspond to P6 cost loaded schedule. List all activities having a budget amount cost loaded. Compile total earnings on the project from notice to proceed to current progress payment request. Show current budget, previous

physical percent complete, to-date physical percent complete, previous earned value, to-date earned value, cost this period and cost to complete on the report for each activity.

- g. Schedule Variance Control (SVC) Diagram: With each schedule submission, provide a SVC diagram showing 1) A Cash Flow Curve indicating planned project cost based on each of projected early and projected late activity finish dates and 2) one curve for Earned Value to-date. Revise Cash Flow Curves when the contract is modified, or as directed by the Contracting Officer Include a legend on report clearly indication 3 curves: early finish, late finish, and earned-value to date.

Use the following settings in Activity Usage Profile Options:

- (1) In the Data section, under Display, the radio box for Cost must be selected.
- (2) In the Data section, under Filter for Bars/Graphs, the checkbox for Total must be checked.
- (3) In the Show Bars/Curves section:
 - (a) Under the By Date column, the checkboxes for Baseline, Actual and Remaining Late must be checked. The checkboxes for Budgeted and Remaining Early must be unchecked.
 - (b) Under the Cumulative column, the checkboxes for Baseline, Actual and Remaining Late must be checked. The checkboxes for Budgeted and Remaining Early must be unchecked.
 - (c) Set the color for Baseline to green.
 - (d) Set the color for Actual to blue.
 - (e) Set the color for Remaining Late to red.
- (4) In the Show Earned Value Curves section, the checkboxes for Planned Value Cost, Earned Value Cost and Estimate at Completion must be unchecked.
- h. Logic Diagram showing timescale from data date to 60 days after data date with filter for longest path. Leave Group By selection blank and sort by finish date in ascending order.
- i. Baseline or Monthly Update Checklist as applicable completed and certified by Qualified Scheduler. Baseline Project Schedule and Monthly Update Schedule Checklists can be found on the Whole Building Design Guide website at <https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-32-17-00-20>
- j. Screen shot PDF of P6 Time Periods Settings referenced in paragraph SCHEDULE SOFTWARE SETTINGS AND RESTRICTIONS, list item d.(2): ADMIN DROP-DOWN MENU, ADMIN PREFERENCES, TIME PERIODS TAB

1.11 CONTRACT MODIFICATION

1.11.1 Time Impact Analysis (TIA)

Submit a Time Impact Analysis with each cost and time proposal for a proposed change. TIA must illustrate the influence of each change or delay on the Contract Completion Date or milestones. No time extensions will be granted nor delay damages paid unless a delay occurs which consumes all available Project Float, impacts the longest path, and extends the Projected Completion beyond the Contract Completion Date.

- a. Each TIA must be in both narrative and schedule form. The narrative must define the scope and conditions of the change; provide start and finish dates of impact, successor and predecessor activity to impact period, responsible party; describe how it originated, and how it impacts the schedule's longest path. The schedule submission must consist of three native XER files:

- (1) Fragnet used to define the scope of the changed condition
- (2) Most recent accepted schedule update as of the time of the impact start date. Update this schedule to show all activity progress as of the time of the impact start date. The impact start date is identified as the time when an existing activity is impeded for either starting or finishing.
- (3) The impacted schedule that has the fragnet inserted in the updated schedule and the schedule "run" so that the new completion date is determined.

- b. For claimed as-built project delay, the inserted fragnet TIA method must be modified to account for as-built events known to occur after the data date of schedule update used. Updated schedules for periods following the impact start date will be used to evaluate how the project progressed (as-built) through the finish of impact. Impact to longest path must be determined for each following update period.
- c. All TIAs must include any mitigation, and must determine the apportionment of the overall delay assignable to each individual delay. Apportionment must provide identification of delay type and classification of delay by compensable and non-compensable events. The associated narrative must clearly describe analysis methodology used, and the findings in a chronological listing beginning with the earliest delay event.

- (1) Identify and classify types of delay defined as follows:

- (a) Force majeure delay (e.g. weather delay): Any delay event caused by something or someone other than the Government or the Contractor, or the risk of which has not been assigned solely to the Government or the Contractor. If the force majeure delay is on the longest path, in absence of other types of concurrent delays, the Contractor is granted an extension of contract time, classified as a non-compensable event.

- (b) A Contractor-delay: Any delay event caused by the Contractor, or the risk of which has been assigned solely to the Contractor. If the contractor-delay is on the longest path, in absence of other types of concurrent delays, Contractor is not granted

extension of contract time, and classified as a non-compensable event. Where absent other types of delays, and having impact to project completion, Contractor must provide to Contracting Officer a Corrective Action Plan identifying plan to mitigate delay.

(c) A Government-delay: Any delay event caused by the Government, or the risk of which has been assigned solely to the Government. If the Government-delay is on the longest path, in absence of other types of concurrent delays, the Contractor is granted an extension of contract time, and classified as a compensable event.

- (2) Functional concurrency must be used to analyze concurrent delays, where: separate delay issues delay project completion, do not necessarily occur at same time, rather occur within same monthly schedule update period at minimum, or within same as-built period under review. If a combination of functionally concurrent delay types occurs, it is considered Concurrent Delay, which is defined in the following combinations:

(a) Government-delay concurrent with contractor-delay: excusable time extension, classified non-compensable event.

(b) Government-delay concurrent with force majeure delay: excusable time extension, classified non-compensable event.

(c) Contractor-delay concurrent with force majeure delay: excusable time extension, classified non-compensable event.

- (3) Pacing delay reacting to another delay (parent delay) equally or more critical than paced activity must be identified prior to pacing. Contracting Officer will notify Contractor prior to pacing. Contractor must notify Contracting Officer prior to pacing. Notification must include identification of parent delay issue, estimated parent delay time period, paced activity(s) identity, and pacing reason(s). Pacing Concurrency is defined as follows:

(a) Government-delay concurrent with contractor-pacing: excusable time extension, classified compensable event.

(b) Contractor-delay concurrent with Government-pacing: inexcusable time extension, classified non-compensable event

- d. Submit electronic file containing the narrative and the source schedule files used in the time impact analysis.

1.12 PROJECT FLOAT

Project Float is the length of time between the Contractor's Projected Completion Milestone and the Contract Completion Date. Project Float available in the schedule will not be for the exclusive use of either the Government or the Contractor.

The use of Resource Leveling or other techniques used for the purpose of artificially adjusting activity durations to consume float and influence longest path is prohibited.

RR1 Repair by Replacement
MCB Camp Lejeune, NC

Project# P1594
27 April 2023

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 33 00
SUBMITTAL PROCEDURES

07/21

PART 1 GENERAL

1.1 SUMMARY

1.1.1 Government-Furnished Information

Submittal register will be delivered to the contractor in hard copy format. Register will have 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 No. and type, e.g. SD-04 Drawings) required in each specification section.

Column (e): Lists one principal paragraph in 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 project requirements.

Column (f): Indicate approving authority for each submittal. The Contracting Officer is approving authority for all submittals.

1.2 DEFINITIONS

1.2.1 Submittal

Shop drawings, product data, samples, and administrative submittals presented for review and approval. Contract Clauses "FAR 52.236-5, Material and Workmanship," paragraph (b) and "FAR 52.236-21, Specifications and Drawings for Construction," paragraphs (d), (e), and (f) apply to all "submittals."

1.2.2 Types of Submittals

All submittals are classified as indicated in paragraph "Submittal Descriptions (SD)". Submittals also are grouped as follows:

- a. Shop drawings: As used in this section, drawings, schedules, diagrams, and other data prepared specifically for this contract, by contractor or through contractor by way of subcontractor, manufacturer, supplier, distributor, or other lower tier contractor, to illustrate portion of work.
- b. Product data: Preprinted material such as illustrations, standard schedules, performance charts, instructions, brochures, diagrams, manufacturer's descriptive literature, catalog data, and other data to illustrate portion of work, but not prepared exclusively

for this contract.

- c. Samples: Physical examples of products, materials, equipment, assemblies, or workmanship that are physically identical to portion of work, illustrating portion of work or establishing standards for evaluating appearance of finished work or both.
- d. Administrative submittals: Data presented for reviews and approval to ensure that administrative requirements of project are adequately met but not to ensure directly that work is in accordance with design concept and in compliance with contract documents.

1.2.3 Submittal Descriptions (SD)

SD-01 Preconstruction Submittals

Certificates of insurance
Surety bonds
List of proposed subcontractors
List of proposed products
Construction Progress Schedule
Submittal schedule
Schedule of values
Health and safety plan
Work plan
Quality control plan
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 or equipment for some portion of the work.

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

SD-04 Samples

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 by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

SD-05 Design Data

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. (Testing must have been within three years of date of contract award for the project.)

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

Report which 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 checklists

Final acceptance test and operational test procedure

SD-07 Certificates

Statements signed by responsible officials of manufacturer of product, system or material attesting that 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 supplier, installer or subcontractor through Contractor, the purpose of which is to further quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

Confined space entry permits.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and Material Safety Data sheets concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

Factory test reports.

SD-10 Operation and Maintenance Data

Data intended to be incorporated in operations and maintenance manuals.

SD-11 Closeout Submittals

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

As-built drawings

Special warranties

Posted operating instructions

Training plan

1.2.4 Approving Authority

Person authorized to approve submittal.

1.2.5 Work

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

1.3 SUBMITTALS

Submit the following in accordance with the requirements of this section.

SD-11 Closeout Submittals

Submittal register

Complete Submittal Package 2 CD/DVD's

1.4 USE OF SUBMITTAL REGISTER

Prepare and maintain submittal register, as the work progresses. Use the hard copy submittal register furnished by the Government or other approved format. Do not change data which is output in columns (c), (d), (e), and (f) as delivered by government; retain data which is output in columns (a), (g), (h), and (i) as approved.

1.4.1 Submittal Register

Submit submittal register as a hard copy. Submit with quality control plan and project schedule required by Section 01 45 00.00 20 QUALITY CONTROL and Section 01 32 16, "Construction Progress Documentation." Do not change data in columns (c), (d), (e), and (f) as delivered by the government. Verify that all submittals required for project are listed and add missing submittals. Complete the following on the register:

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

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

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

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

1.4.2 Contractor Use of Submittal Register

Update the following fields in the government-furnished submittal register.

Column (b) Transmittal Number: Contractor assigned list of consecutive numbers.

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

Column (l) List date of submittal transmission.

Column (q) List date approval received.

1.4.3 Approving Authority Use of Submittal Register

Update the following fields in the government-furnished submittal register.

Column (b).

Column (l) List date of submittal receipt.

Column (m) through (p).

Column (q) List date returned to contractor.

1.4.4 Contractor Action Code and Action Code

Entries used will be as follows (others may be prescribed by Transmittal Form):

NR - Not Received

AN - Approved as noted

A - Approved

RR - Disapproved, Revise, and Resubmit

1.4.5 Copies Delivered to the Government

Deliver one copy of submitted register updated by contractor to government with each invoice request.

1.4.6 Submittals reserved for Marine Corps North Carolina IPT approval

- a. Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM: All submittals. Provide an information copy of all submittals to Base Telephone through the Contracting Officer. Base Telephone will coordinate their review and approval through the Marine Corps

North Carolina IPT.

- b. Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP): All submittals. Provide an information copy of all submittals to Base Telephone through the Contracting Officer. Base Telephone will coordinate their review and approval through the Marine Corps North Carolina IPT.

1.5 PROCEDURES FOR SUBMITTALS

1.5.1 Reviewing, Certifying, Approving Authority

QC organization shall be responsible for reviewing and certifying that submittals are in compliance with contract requirements. The Contracting Officer is the approving authority for all submittals.

1.5.2 Constraints

- a. Submittals listed or specified in this contract shall conform to provisions of this section, unless explicitly stated otherwise.
- b. Submittals shall be complete for each definable feature of work; components of definable feature interrelated as a system shall be submitted at same time.
- c. When acceptability of a submittal is dependent on conditions, items, or materials included in separate subsequent submittals, submittal will be returned without review.
- d. Approval of a separate material, product, or component does not imply approval of assembly in which item functions.

1.5.3 Scheduling

- a. Coordinate scheduling, sequencing, preparing and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow for potential requirements to resubmit.
- b. Except as specified otherwise, allow review period, beginning with receipt by approving authority, that includes at least 15 working days for submittals for QC manager approval and 20 working days for submittals for contracting officer approval. Period of review for submittals with contracting officer approval begins when Government receives submittal from QC organization. Period of review for each resubmittal is the same as for initial submittal.
- c. For submittals requiring review by fire protection engineer, allow review period, beginning when government receives submittal from QC organization, of 45 working days for return of submittal to the contractor. Period of review for each resubmittal is the same as for initial submittal.

1.5.4 Variations

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

1.5.4.1 Considering Variations

Discussion with contracting officer prior to submission, will help ensure functional and quality requirements are met and minimize rejections and resubmittals. When contemplating a variation which results in lower cost, consider submission of the variation as a Value Engineering Change Proposal (VECP).

1.5.4.2 Proposing Variations

When proposing variation, deliver 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. If lower cost is a benefit, also include an estimate of the cost saving. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

1.5.4.3 Warranting That Variation Are Compatible

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

1.5.4.4 Review Schedule Is Modified

In addition to normal submittal review period, a period of 10 working days will be allowed for consideration by the Government of submittals with variations.

1.5.5 Contractor's Responsibilities

- a. Determine and verify field measurements, materials, field construction criteria; review each submittal; and check and coordinate each submittal with requirements of the work and contract documents.
- b. Transmit submittals to QC organization in accordance with schedule on approved Submittal Register, and to prevent delays in the work, delays to government, or delays to separate contractors.
- c. Advise contracting officer of variation, as required by paragraph entitled "Variations."
- d. Correct and resubmit submittal as directed by approving authority. When resubmitting disapproved transmittals or transmittals noted for resubmittal, the contractor shall provide copy of that previously submitted transmittal including all reviewer comments for use by approving authority. Direct specific attention in writing or on resubmitted submittal, to revisions not requested by approving authority on previous submissions.
- e. Furnish additional copies of submittal when requested by contracting officer, to a limit of 20 copies per submittal.
- f. Complete work which must be accomplished as basis of a submittal in time to allow submittal to occur as scheduled.

- g. Ensure no work has begun until submittals for that work have been returned as "approved," or "approved as noted", except to the extent that a portion of work must be accomplished as basis of submittal.

1.5.6 QC Organization Responsibilities

- a. Note date on which submittal was received from contractor on each submittal.
- b. Review each submittal; and check and coordinate each submittal with requirements of work and contract documents.
- c. Review submittals for conformance with project design concepts and compliance with contract documents.
- d. Act on submittals, determining appropriate action based on QC organization's review of submittal.

(1) When QC manager is approving authority, take appropriate action on submittal from the possible actions defined in paragraph entitled, "Actions Possible."

(2) When contracting officer is approving authority or when variation has been proposed, forward submittal to Government with certifying statement or return submittal marked "not reviewed" or "revise and resubmit" as appropriate. The QC organization's review of submittal determines appropriate action.

- e. Ensure that material is clearly legible.
- f. Stamp each sheet of each submittal with QC certifying statement or approving statement, except that data submitted in bound volume or on one sheet printed on two sides may be stamped on the front of the first sheet only.

(1) When approving authority is contracting officer, QC organization will certify submittals forwarded to contracting officer with the following certifying statement:

"I hereby certify that the (equipment) (material) (article) shown and marked in this submittal is that proposed to be incorporated with contract Number N40085-_____, is in compliance with the contract drawings and specification, can be installed in the allocated spaces, and is submitted for Government approval.

Certified by Submittal Reviewer _____, Date _____
(Signature when applicable)

Certified by QC manager _____, Date _____"
(Signature)

- g. Sign certifying statement or approval statement. The person signing certifying statements shall be QC organization member designated in the approved QC plan. The signatures shall be in original ink. Stamped signatures are not acceptable.
- h. Update submittal register as submittal actions occur and maintain the submittal register at project site until final acceptance of

all work by contracting officer.

- i. Retain a copy of approved submittals at project site, including contractor's copy of approved samples.

1.5.7 Government's Responsibilities

When approving authority is contracting Officer, the Government will:

- a. Note date on which submittal was received from QC manager, on each submittal for which the contracting officer is approving authority.
- b. Review submittals for approval within 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 entitled "Actions Possible" and with markings appropriate for action indicated.

1.5.8 Actions Possible

Submittals will be returned with one of the following notations:

- a. Submittals marked "not reviewed" will indicate 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.
- b. Submittals marked "approved" "approved as submitted" authorize contractor to proceed with work covered.
- c. Submittals marked "approved as noted" authorize contractor to proceed with work as noted provided contractor takes no exception to the notations.
- d. Submittals marked "revise and resubmit" or "disapproved" indicate submittal is incomplete or does not comply with design concept or requirements of the contract documents and shall be resubmitted with appropriate changes. No work shall proceed for this item until resubmittal is approved.

1.6 FORMAT OF SUBMITTALS

1.6.1 Complete Submittal Package

Contractor shall make electronic copies of all submittals, including the approved transmittal sheets, and provide two (2) CD/DVD's containing all submittals for the project.

The CD/DVD's shall be marked "Complete Submittal Package - Contract #_____."

1.6.2 Transmittal Form

Transmit each submittal, except sample installations and sample panels, to

office of approving authority. Transmit submittals with transmittal form prescribed by contracting officer and standard for project. The transmittal form shall identify contractor, indicate date of submittal, and include information prescribed by transmittal form and required in paragraph entitled "Identifying Submittals." Process transmittal forms to record actions regarding sample panels and sample installations.

1.6.3 Identifying Submittals

Identify submittals, except sample panel and sample installation, with the following information permanently adhered to or noted on each separate component of each submittal and noted on transmittal form. Mark each copy of each submittal identically, with the following:

- a. Project title and location.
- b. Construction contract number.
- c. Section number of the specification section by which submittal is required.
- d. Submittal description (SD) number of each component of submittal.
- e. When a resubmission, alphabetic suffix on submittal description, for example, SD-10A, to indicate resubmission.
- f. Name, address, and telephone number of subcontractor, supplier, manufacturer and any other second tier contractor associated with submittal.
- g. Product identification and location in project.

1.6.4 Format for Product Data

- a. Present product data submittals for each section as a complete, bound volume. Include table of contents, listing page and catalog item numbers for product data.
- b. Indicate, by prominent notation, each product which is being submitted; indicate specification section number and paragraph number to which it pertains.
- c. Supplement product data with material prepared for project to satisfy submittal requirements for which product data does not exist. Identify this material as developed specifically for project.

1.6.5 Format for Shop Drawings

- a. Shop drawings shall not be less than 8 1/2 by 11 inches nor more than 30 by 42 inches.
- b. Present 8 1/2 by 11 inches sized shop drawings as part of the bound volume for submittals required by section. Present larger drawings in sets.
- c. Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to information required in paragraph entitled "Identifying Submittals."

- d. Dimension drawings, except diagrams and schematic drawings; prepare drawings demonstrating interface with other trades to scale. Shop drawing dimensions shall be the same unit of measure as indicated on the contract drawings. Identify materials and products for work shown.

1.6.6 Format of Samples

- a. Furnish samples in sizes below, unless otherwise specified or unless the manufacturer has prepackaged samples of approximately same size as specified:
 - (1) Sample of Equipment or Device: Full size.
 - (2) Sample of Materials Less Than 2 by 3 inches: Built up to 8 1/2 by 11 inches.
 - (3) 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.
 - (4) 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.
 - (5) Sample of Non-Solid Materials: Pint. Examples of non-solid materials are sand and paint.
 - (6) Color Selection Samples: 2 by 4 inches.
 - (7) Sample Panel: 4 by 4 feet.
 - (8) Sample Installation: 100 square feet.
- b. Samples Showing Range of Variation: Where variations are unavoidable due to nature of the materials, submit sets of samples of not less than three units showing extremes and middle of range.
- c. Reusable Samples: Incorporate returned samples into work only if so specified or indicated. Incorporated samples shall be in undamaged condition at time of use.
- d. Recording of Sample Installation: Note and preserve the notation of area constituting sample installation but remove notation at final clean up of project.
- e. When color, texture or pattern is specified by naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.

1.6.7 Format of Administrative Submittals

- a. When submittal includes a document which is to be used in project or become part of project record, other than as a submittal, do not apply contractor's approval stamp to document, but to a separate sheet accompanying document.
- b. Operation and Maintenance Manual Data: Submit in accordance with

Section 01 78 23, "Operation and Maintenance Data." Include components required in that section and the various technical sections.

1.7 QUANTITY OF SUBMITTALS

1.7.1 Number of Copies of Product Data

- a. Submit five copies of submittals of product data requiring review and approval only by the Contracting Officer. Submit three copies of submittals of product data for operation and maintenance manuals.

1.7.2 Number of Copies of Shop Drawings

Submit shop drawings in compliance with quantity requirements specified for product data.

1.7.3 Number of Samples

- a. Submit two samples, or two sets of samples showing range of variation, of each required item. One approved sample or set of samples will be retained by approving authority and one will be returned to contractor.
- b. Submit one sample panel. Include components listed in technical section or as directed.
- c. Submit one sample installation, where directed.
- d. Submit one sample of non-solid materials.

1.7.4 Number of Copies of Administrative Submittals

- a. Unless otherwise specified, submit administrative submittals compliance with quantity requirements specified for product data.
- b. Submit administrative submittals required under "SD-19 Operation and Maintenance Manuals" to conform to Section 01 78 23, "Operation and Maintenance Data."

1.8 FORWARDING SUBMITTALS

1.8.1 Samples and Submittals

Except as otherwise noted, submit samples and submittals to:

MBF Architects, PA
317-C Pollock St.
New Bern, NC 28560

1.8.1.1 Administrative Submittals

Submit administrative submittals for asbestos/lead removal and environmental protection plan to the Resident Officer in Charge of Construction (ROICC/OICC).

1.8.1.2 Fire Protection and Fire Alarm System Submittals

Submit fire protection and fire alarm system submittals to Resident Officer in Charge of Construction (ROICC/OICC), Jacksonville, North Carolina Area, 1005 Michael Road, Camp Lejeune, NC 28542-2521.

1.8.1.3 TAB Submittals

Submit to ROICC/OICC for all projects.

1.8.1.4 HVAC DDC Submittals

Submit HVAC DDC Submittals, Section 23 09 23.13 to the specified address in paragraph 1.8.1. Concurrently submit shop drawings, Product Data, and Design Data electronically to Resident Officer in Charge of Construction (ROICC/OICC), Jacksonville, North Carolina Area. Electronic copy shall be PDF and should be submitted via email. Only if file size exceeds email limits, submit as a CD or DVD.

1.8.2 Shop Drawings, Product Data, and O&M Data

As soon as practicable after award of the contract, and before procurement or fabrication, submit shop drawings, product data and O&M Data required in the technical sections of this specification.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 20 00	SD-01 Preconstruction Submittals														
			Schedule of prices	1.3													
		01 30 00	SD-01 Preconstruction Submittals														
			List of contact personnel	1.4.1													
		01 30 01.00 22	SD-01 Preconstruction Submittals														
			Preliminary (Pre-Final) FF&E	1.4.3	G ID												
			Package														
			FF&E Schedule and Schedule	1.3.3	G ID												
			Updates														
			Contractor's Interior Designer's	1.3.1	G ID												
			Qualifications														
			Best Value Determination	1.3.4	G ID												
		01 31 50	SD-11 Closeout Submittals														
			Interim DD-1354, Transfer &	1.2													
			Acceptance of Military Real														
			Property														
		01 32 16	SD-01 Preconstruction Submittals														
			Construction schedule	1.2													
			Equipment delivery schedule	1.3													
		01 32 17.00 20	SD-01 Preconstruction Submittals														
			Baseline NAS	1.2.2	G												
			Designated Project Scheduler	1.9	G												
			SD-07 Certificates														
			Three-Week Look Ahead	1.3	G												
			Schedule														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 32 17.00 20	Monthly Network Analysis Updates	1.4.1	G												
			SD-11 Closeout Submittals As-Built Schedule	1.4.2	G												
		01 33 00	SD-11 Closeout Submittals Submittal register	1.4.1													
			Complete Submittal Package	1.6.1													
		01 33 29	SD-01 Preconstruction Submittals Preliminary High Performance and Sustainable Building Checklist	1.5.3.2	G												
			Sustainability Action Plan	1.4.1	G												
			Preliminary Sustainability eNotebook	1.5.3.2	G												
			SD-06 Test Reports														
			Third Party Certification Design Compliance Report	1.5.3.2	G												
			SD-11 Closeout Submittals														
			Final High Performance and Sustainable Building Checklist	1.5.3.2	G												
			Final Sustainability eNotebook	1.5.3.2	G												
			Amended Final Sustainability eNotebook	1.5.3.2	G												
			Amended Final High Performance and Sustainable Building Checklist	1.5.3.2	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 33 29	Third Party Certification Certificate, Assessment, or Validation and Compliance Report	3.2	G												
		01 35 29	SD-01 Preconstruction Submittals														
			Accident Prevention Plan (APP)	1.9													
			Activity Hazard Analysis (AHA)	1.10													
			Crane Critical Lift Plan	1.9.1													
			Crane Work Plan	1.9.1													
			Crane Operators	1.7.1.4													
			SD-06 Test Reports														
			Reports	1.14													
			Accident Reports	1.14.1													
			Monthly Exposure Reports	1.14.3													
			Regulatory Citations and Violations	1.14.4													
			Crane Reports	1.14.5													
			SD-07 Certificates														
			Confined Space Entry Permit	1.11													
			Certificate of Compliance	1.14.6													
			Third Party Certification of Barge-Mounted Mobile Cranes	1.14.7													
		01 45 00.00 20	SD-01 Preconstruction Submittals														
			Construction Quality Control (QC) Plan	1.6.1	G												
			Indoor Air Quality (IAQ) Management Plan	1.16	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 45 35	SD-01 Preconstruction Submittals														
			Written NDT Practices	3.1.2													
			SD-06 Test Reports														
			Daily Reports	3.1.2													
			Biweekly Reports	3.1.1													
			SD-07 Certificates														
			AISC Certified Steel Fabricator	2.1													
			Steel Joist Institute Membership	2.1													
			Certificate of Compliance	2.1													
			Special Inspector	1.5	G												
			Qualification Records	3.1.2													
			SD-11 Closeout Submittals														
			Interim Report	3.1.2	G												
			Comprehensive Final Report	3.1.2	G												
		01 50 00	SD-03 Product Data														
			Backflow preventers	2.1													
			SD-06 Test Reports														
			Backflow Preventer Tests	3.1													
			SD-07 Certificates														
			Backflow Tester Certifications	1.3													
			Backflow Preventers Certificate	1.3.1													
		01 57 19	SD-01 Preconstruction Submittals														
			Environmental protection plan	1.6.1													
			Preconstruction survey	1.6.4													
			SD-06 Test Reports														
			Abrasive blasting	3.7.1													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/ RE V W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 57 19	SD-11 Closeout Submittals														
			Solid waste disposal permit	1.4.1													
			Disposal permit for hazardous waste	1.4.2													
			Environmental training documentation	1.2													
			Permit to transport hazardous waste	1.4.3													
			Hazardous waste certification	1.4.4													
			Erosion and sediment control inspection reports	1.4.5													
			Environmental Plan Review	1.6.3													
			Annual Report of Products	2.1													
			Containing Recovered Materials														
		01 60 00	SD-07 Certificates														
			Certificate of North Carolina Licensed Applicator	1.2.1													
			SD-11 Closeout Submittals														
			Field Pesticide/Herbicide Management Record Form	3.2													
		01 74 19	SD-01 Preconstruction Submittals														
			Construction Waste Management Plan	1.7	G												
			SD-11 Closeout Submittals														
			Final Construction Waste Diversion Report	1.9	S												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 78 00	SD-10 Operation and Maintenance Data														
			Equipment/product warranty list	1.4.1													
			SD-11 Closeout Submittals														
			As-built drawings	1.2.1													
			Record of materials	1.2.2													
			Maximo requirements	1.3													
			Complete Submittal Package	1.6													
			Equipment/product warranty tag	1.4.2													
		01 78 23	SD-10 Operation and Maintenance Data														
			O&M Database	1.4													
			Training Plan	3.1.1													
			Training Outline	3.1.3													
			Training Content	3.1.2													
			SD-11 Closeout Submittals														
			Training Video Recording	3.1.4													
			Validation of Training Completion	3.1.6													
		01 78 30.00 22	SD-11 Closeout Submittals														
			GIS Data Deliverables	1.3.6	G												
		01 91 00.15 20	SD-06 Test Reports														
			Design Review Report	3.1	G												
			Interim Construction Phase	3.5	G												
			Commissioning Plan														
			Final Construction Phase	3.5	G												
			Commissioning Plan														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 91 00.15 20	Initial Commissioning Report	3.9	G												
			Issues Log	1.11	G												
			Completed Pre-Functional Checklists	3.6	G												
			Completed Building Envelope Inspection Checklists	3.5.5	G												
			SD-07 Certificates														
			Commissioning Firm	1.9	G												
			Certificate Of Readiness	1.12	G												
			SD-11 Closeout Submittals														
			Final Commissioning Report	3.9	G												
		02 41 00	SD-01 Preconstruction Submittals														
			Demolition Plan	1.2.2	G												
			Existing Conditions	1.9													
			SD-07 Certificates														
			Notification	1.6	G												
			SD-11 Closeout Submittals														
			Receipts	3.3.2													
		03 30 00	SD-01 Preconstruction Submittals														
			Quality Control Plan	1.6.5	G												
			Quality Control Personnel	1.6.6	G												
			Certifications														
			Quality Control Organizational Chart	1.6.6													
			Laboratory Accreditation	1.6.8	G												
			Maturity Method Data	3.3.10													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		03 30 00	SD-02 Shop Drawings														
			Reinforcing Steel	1.6.2.1	G												
			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 Hardeners and Sealers	2.4.3.1													
			Admixtures	2.3.4													
			Mechanical Reinforcing Bar Connectors	2.6.2													
			Waterstops	2.2.2													
			Biodegradable Form Release Agent	2.2.3													
			Nonshrink Grout	2.4.2													
			SD-05 Design Data														
			Concrete Mix Design	1.6.1.1	G												
			SD-06 Test Reports														
			Concrete Mix Design	1.6.1.1	G												
			Fly Ash	1.6.3.1													
			Pozzolan	1.6.3.1													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		03 30 00	Slag Cement	1.6.3.2													
			Aggregates	1.6.3.3													
			Tolerance Report	3.10.2.1													
			Compressive Strength Tests	3.14.3.3	G												
			Unit Weight of Structural Concrete	3.14.3.5													
			Air Content	3.14.3.4													
			Slump Tests	3.14.3.1													
			Water	2.3.2													
			SD-07 Certificates														
			Reinforcing Bars	2.6.1													
			Welder Qualifications	1.8													
			Field Testing Technician and Testing Agency	1.6.6.2													
			SD-08 Manufacturer's Instructions														
			Joint Sealants	2.4.5													
			Curing Compound	2.4.1													
		03 30 53	SD-03 Product Data														
			Air-Entraining Admixture	2.2.3.1													
			Water-Reducing or Retarding Admixture	2.2.3.2													
			Curing Materials	2.2.10													
			Expansion Joint Filler Strips, Premolded	2.2.6													
			Conveying and Placing Concrete	3.2													
			Formwork	2.2.7													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION REVIEWER	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		03 30 53	Mix Design Data	2.3	G												
			Ready-Mix Concrete	2.3													
			Mechanical Reinforcing Bar	2.2.5													
			Connectors														
			SD-06 Test Reports														
			Aggregates	2.2.2													
			Concrete Mixture Proportions	2.1.3	G												
			Compressive Strength Testing	3.8.3	G												
			Slump	3.8.3	G												
			Air Content	3.8.3													
			Water	2.2.4													
			SD-07 Certificates														
			Cementitious Materials	2.2.1													
			Pozzolan	2.2.1.2													
			Aggregates	2.2.2													
			Delivery Tickets	2.3													
		03 45 00	SD-01 Preconstruction Submittals														
			Pre-Installation Meeting	1.12.5													
			SD-02 Shop Drawings														
			Precast Drawings	1.12.1	G												
			SD-03 Product Data														
			Cast-In Embedded Items And	2.3	G												
			Connectors														
			Connection Devices	2.3.2	G												
			Admixtures	2.2.5													
			Gasket	2.5													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/E REVIEW WR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		03 45 00	Bearing Pads	2.6													
			SD-04 Samples														
			Concrete Wall Panel Surface	1.12.2	G												
			Finish														
			Mock-up	1.12.4													
			SD-05 Design Data														
			Design Calculations	1.5.4	G												
			Contractor-Furnished Mix Design	2.1.1	G												
			Repair of Surface Defects	2.4.9	G												
			Thermal Calculations	1.5.5	G												
			SD-06 Test Reports														
			Strength Tests	1.11.2	G												
			Slump	1.11.2													
			Air Content	1.11.2													
			Test for Concrete Materials	1.11.1													
			Water	2.2.6													
			Testing Precast Units for Strength	3.6.4													
			SD-07 Certificates														
			Manufacturer's Qualifications	1.4	G												
			Fabricator Quality Certifications	1.8.1													
			Erector Certification	1.9													
			Erector's Post Audit Declaration	1.10													
			SD-08 Manufacturer's Instructions														
			Installation	3.3	G												
			Cleaning	3.8	G												
			SD-11 Closeout Submittals														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		03 45 00	Batch Ticket Information	1.12.3	G												
			Recycled Content for Fly Ash and Pozzolan	2.2.1	S												
			Recycled Content for Ground Iron Blast-Furnace Slag	2.2.1	S												
			Recycled Content for Silica Fume	2.2.1	S												
		04 20 00	SD-02 Shop Drawings														
			Detail Drawings	3.4.1.1	G												
			SD-03 Product Data														
			Hot Weather Procedures	1.5.1	G												
			Cold Weather Procedures	1.5.2	G												
			Clay or Shale Brick	2.2.2	G												
			Insulation	2.6.7	G												
			SD-04 Samples														
			Mock-Up Panel	1.3.1.1	G												
			Clay or Shale Brick	2.2.2	G												
			Clay Masonry Expansion-Joint Materials	2.6.5	G												
			SD-05 Design Data														
			Masonry Compressive Strength	2.1.2	G												
			Bracing Calculations	3.2.4	G												
			SD-06 Test Reports														
			Efflorescence Test	2.2.2.1.4													
			Field Testing of Mortar	3.6.1.1													
			Field Testing of Grout	3.6.1.2													
			Prism Tests	3.6.1.4													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
RR1 Repair by Replacement																	
ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION OR REVIEW	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		04 20 00	SD-07 Certificates														
			Clay or Shale Brick	2.2.2													
			Concrete Masonry Units (CMU)	2.2.3.2													
			Cementitious Materials	2.4.1.1													
			Admixtures for Masonry Mortar	2.4.1.4													
			Admixtures for Grout	2.4.2.2													
			Anchors, Ties, and Bar	2.6.2													
			Positioners														
			Joint Reinforcement	2.6.3													
			Insulation	2.6.7													
			SD-08 Manufacturer's Instructions														
			Admixtures for Masonry Mortar	2.4.1.4													
			Admixtures for Grout	2.4.2.2													
			SD-10 Operation and Maintenance														
			Data														
			Take-Back Program	3.8													
			SD-11 Closeout Submittals														
			Clay Units	2.2.2.1.3	S												
			Recycled Content	2.2.3.2.1	S												
		05 12 00	SD-01 Preconstruction Submittals														
			Erection and Erection Bracing	1.3.1.1	G												
			Drawings														
			SD-02 Shop Drawings														
			Fabrication Drawings	1.3.2	G												
			SD-03 Product Data														
			Shop Primer	2.6.2													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		05 12 00	Welding Electrodes and Rods	2.4.1													
			Direct Tension Indicator Washers	2.3.2.3													
			Non-Shrink Grout	2.4.2													
			Tension Control Bolts	2.3.3													
			Recycled Content for Structural Steel	2.2.1	S												
			Recycled Content for Structural Steel Tubing	2.2.2	S												
			Recycled Content for Steel Pipe	2.2.3	S												
			SD-05 Design Data														
			Design Calculations for Steel Connections	1.3.3	G												
			SD-06 Test Reports														
			Class B Coating	2.6.2													
			Bolts, Nuts, and Washers	2.3													
			Weld Inspection Reports	3.7.1.2													
			Direct Tension Indicator Washer Inspection Reports	3.7.2.1													
			Bolt Testing Reports	3.7.3.1													
			Embrittlement Test Reports	3.7.4													
			SD-07 Certificates														
			Steel	2.2													
			Bolts, Nuts, and Washers	2.3													
			Galvanizing	2.5													
			Welding Procedures and Qualifications	1.3.4.1													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N A / E R E V W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		05 12 00	Welding Electrodes and Rods	2.4.1													
			Certified Welding Inspector	3.7.1.1													
			NDT Technician	3.7.1.2													
			Welding Procedure Specifications (WPS)	3.4													
			Overhead, Top Running Crane Rail Beam	1.3.4.2													
		05 30 00	SD-02 Shop Drawings														
			Fabrication Drawings	1.3.5	G												
			SD-03 Product Data														
			Accessories	2.2													
			Deck Units	2.1													
			Galvanizing Repair Paint	2.1.3													
			Touch-Up Paint	2.1.3													
			Welding Equipment	1.3.3													
			Welding Rods and Accessories	1.3.3													
			Recycled Content of Steel Products	2.1	S												
			SD-04 Samples														
			Metal Roof Deck Units	2.1.1													
			Flexible Closure Strips	2.2.4													
			SD-05 Design Data														
			Deck Units	2.1	G												
			SD-07 Certificates														
			Powder-Actuated Tool Operator	1.3.2													
			Welder Qualifications	1.3.3													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		05 30 00	Welding Procedures	1.3.3													
			Fire Safety	1.3.4.1													
			Wind Storm Resistance	1.3.4.2													
			Manufacturer's Certificate	1.3.1													
			Stud Manufacture's Certification	2.2.10													
			Stud Manufacture's Test Reports	2.2.10													
		05 40 00	SD-02 Shop Drawings														
			Framing Components	1.5.1	G												
			SD-03 Product Data														
			Studs, Joists	2.1													
			Recycled Content of Steel	2.1	S												
			Products														
			SD-05 Design Data														
			Metal Framing Calculations	1.5.2	G												
			SD-07 Certificates														
			Welds	3.2.1													
		05 51 00	SD-02 Shop Drawings														
			Iron and Steel Hardware	2.1	G												
			Steel Shapes, Plates, Bars, and	2.1	G												
			Strips														
			Metal Stair System	2.2.1	G												
			SD-03 Product Data														
			Structural Steel Plates, Shapes,	2.4.1	G												
			and Bars														
			Structural Steel Tubing	2.4.2	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N O R A / E R E V I O W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		05 51 00	Hot-Rolled Carbon Steel Sheets and Strips	2.4.5	G												
			Cold-Finished Steel Bars	2.4.4	G												
			Hot-Rolled Carbon Steel Bars	2.4.3	G												
			Cold-Rolled Carbon Steel Sheets	2.4.6	G												
			Galvanized Carbon Steel Sheets	2.4.7	G												
			Cold-Drawn Steel Tubing	2.4.8	G												
			Gray Iron Castings	2.4.9	G												
			Malleable Iron Castings	2.4.10	G												
			Masonry Anchorage Devices	2.3.2	G												
			Protective Coating	2.2.3	G												
			Steel Pan Stairs	2.2.2	G												
			Steel Stairs	2.3.1	G												
			SD-07 Certificates														
			Welding Procedures	1.3.1	G												
			Welder Qualification	1.3.1	G												
			SD-08 Manufacturer's Instructions														
			Structural Steel Plates, Shapes, and Bars	2.4.1	G												
			Structural Steel Tubing	2.4.2	G												
			Hot-Rolled Carbon Steel Sheets and Strips	2.4.5	G												
			Cold-Finished Steel Bars	2.4.4	G												
			Hot-Rolled Carbon Steel Bars	2.4.3	G												
			Cold-Rolled Carbon Steel Sheets	2.4.6	G												
			Galvanized Carbon Steel Sheets	2.4.7	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		05 51 00	Cold-Drawn Steel Tubing	2.4.8	G												
			Gray Iron Castings	2.4.9	G												
			Malleable Iron Castings	2.4.10	G												
			Protective Coating	2.2.3	G												
			Masonry Anchorage Devices	2.3.2	G												
		05 52 00	SD-02 Shop Drawings														
			Iron and Steel Hardware	3.2	G												
			Steel Shapes, Plates, Bars and Strips	3.2	G												
			SD-03 Product Data														
			Structural-Steel Plates, Shapes, and Bars	2.2.1	G												
			Structural-Steel Tubing	2.2.2	G												
			Cold-Finished Steel Bars	2.2.4	G												
			Hot-Rolled Carbon Steel Bars	2.2.3	G												
			Cold-Drawn Steel Tubing	2.2.5	G												
			Concrete Inserts	2.2.7	G												
			Masonry Anchorage Devices	2.2.8	G												
			Protective Coating	2.1.2	G												
			Steel Railings and Handrails	2.2.10	G												
			SD-07 Certificates														
			Welding Procedures	1.3.1	G												
			Welder Qualification	1.3.2	G												
			SD-08 Manufacturer's Instructions														
			Installation Instructions	3.2													
		06 10 00	SD-06 Test Reports														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		06 10 00	Preservative-treated	1.4.2													
			SD-07 Certificates														
			Certificates of Grade	1.8.1													
		06 61 16	SD-02 Shop Drawings														
			Detail Drawings	1.4.2	G												
			Installation	3.1	G												
			SD-03 Product Data														
			Solid Polymer Material	2.1													
			Qualifications	1.4.1													
			Fabrications	2.3													
			Indoor air quality for solid surface	2.2.4													
			seam and sealant products														
			SD-04 Samples														
			Material	2.1	G												
			SD-06 Test Reports														
			Solid Polymer Material	2.1													
			SD-07 Certificates														
			Fabrications	2.3													
			Qualifications	1.4.1													
			Indoor Air Quality for solid	2.1													
			surface fabrication products														
			SD-10 Operation and Maintenance														
			Data														
			Clean-up	3.2													
		07 05 23	SD-01 Preconstruction Submittals														
			Work Plan	1.4	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION REVIEW OR E	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		07 05 23	SD-03 Product Data														
			Thermal Imaging Camera	2.2	G												
			SD-05 Design Data														
			Envelope Surface Area	3.2	G												
			Calculations														
			SD-07 Certificates														
			Pressure Test Agency	1.6.2.1													
			Thermographer Qualifications	1.6.2.2													
			Test Instruments	1.6.3													
			Date Of Last Calibration	1.6.3													
			SD-06 Test Reports														
			Pressure Test Procedures	3.5	G												
			Air Leakage Test Report	1.6.4	G												
			Air Leakage Test Report	3.5.6	G												
			Diagnostic Test Report	1.6.4	G												
			Diagnostic Test Report	3.6.5	G												
		07 21 13	SD-03 Product Data														
			Manufacturer's Standard Details	1.3	G												
			Block or Board Insulation	2.1	G												
			Accessories	2.2	G												
			Recycled Content for Block or	2.1.4	S												
			Board Insulation														
			SD-07 Certificates														
			Block or Board Insulation	2.1	G												
			Protection Board or Coatings	1.4	G												
			Special Warranties	1.7	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		07 21 13	Special Warranties	1.7	G												
			Indoor Air Quality For Block Or Board Insulation	2.1.5	S												
			SD-08 Manufacturer's Instructions														
			Block or Board Insulation	2.1													
			Adhesive	2.2.1													
		07 21 16	SD-03 Product Data														
			Blanket Insulation	2.1													
			Blanket Insulation	2.2													
			Recycled Content for Insulation Materials	2.1.2	S												
			Accessories	2.3													
			SD-07 Certificates														
			Indoor Air Quality for Insulation Materials	2.1.4	S												
			SD-08 Manufacturer's Instructions														
			Insulation	3.1.1													
		07 22 00	SD-02 Shop Drawings														
			Insulation Board Layout	1.3	G												
			SD-03 Product Data														
			Insulation	2.1	G												
			Fasteners	2.2	G												
			Recycled Content For Insulation	2.1.2	S												
			SD-07 Certificates														
			Installer Qualifications	1.6	G												
			Indoor Air Quality For Insulation	2.1.3	S												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		07 22 00	SD-08 Manufacturer's Instructions														
			Fasteners	2.2	G												
			Insulation	2.1	G												
		07 27 10.00 10	SD-02 Shop Drawings														
			Air Barrier System Shop Drawings	2.1	G												
			SD-03 Product Data														
			Air Barrier System Product Data	2.1	G												
			SD-04 Samples														
			Material Samples For Air Barrier System	2.1	G												
			SD-05 Design Data														
			Design Data And Calculations For The Air Barrier System	1.8	G												
			SD-06 Test Reports														
			Design Review Report	1.8	G												
			Testing and Inspection	3.1.2	G												
			SD-07 Certificates														
			Air Barrier Inspector	1.7	G												
		07 27 19.01	SD-01 Preconstruction Submittals														
			Qualifications of Manufacturer	1.8.1	G												
			Qualifications of Installer	1.8.2	G												
			SD-02 Shop Drawings														
			Self-adhering Air Barrier	1.4	G												
			SD-03 Product Data														
			Self-adhering Air Barrier	1.4	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		07 27 19.01	Primers, Adhesives, and Mastics	2.2	G												
			Safety Data Sheets	1.4.2	G												
			SD-06 Test Reports														
			Field Peel Adhesion Test	1.6	G												
			Flame Propagation of Wall Assemblies	1.4.3	G												
			Flame Spread and Smoke Developed Index Ratings	1.4.3	G												
			Site Inspections and Testing	3.4.1	G												
			SD-07 Certificates														
			Self-adhering Air Barrier	1.4	G												
			SD-08 Manufacturer's Instructions														
			Self-adhering Air Barrier	1.4	G												
			Primers, Adhesives, and Mastics	2.2	G												
		07 27 26	SD-01 Preconstruction Submittals														
			Qualifications of Manufacturer	1.9.1	G												
			SD-02 Shop Drawings														
			Fluid-Applied Membrane Air Barrier	1.4	G												
			SD-03 Product Data														
			Fluid-Applied Membrane Air Barrier	1.4	G												
			Transition Membrane	2.3	G												
			Primers, Adhesives, and Mastics	2.2	G												
			Reinforcement	2.6	G												
			Safety Data Sheets	1.4.2	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		07 27 26	SD-04 Samples														
			Mockup	1.4.3	G												
			SD-06 Test Reports														
			Capillary Moisture Test	1.6	G												
			Field Peel Adhesion Test	1.4.4	G												
			Flame Propagation of Wall Assemblies	1.4.4	G												
			Flame Spread and Smoke Developed Index Ratings	1.4.4	G												
			Site Inspections	3.4.1	G												
			SD-07 Certificates														
			Fluid-Applied Membrane Air Barrier	1.4	G												
			Transition Membrane	2.3	G												
			SD-08 Manufacturer's Instructions														
			Fluid-Applied Membrane Air Barrier	1.4	G												
			Transition Membrane	2.3	G												
			Primers, Adhesives, and Mastics	2.2	G												
		07 60 00	SD-02 Shop Drawings														
			Exposed Sheet Metal	2.2.1	G												
			Gutters	3.1.14	G												
			Downspouts	3.1.15	G												
			Drip Edges	3.1.13	G												
			Open Valley Flashing	3.1.16	G												
			Eave Flashing	3.1.17	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		07 60 00	Recycled Content	2.1	S												
			SD-04 Samples														
			Finish Samples	1.4.2	G												
			SD-08 Manufacturer's Instructions														
			Instructions for Installation	1.4.3	G												
			Quality Control Plan	3.5	G												
			SD-10 Operation and Maintenance														
			Data														
			Cleaning and Maintenance	1.4.3	G												
		07 61 15.00 20	SD-02 Shop Drawings														
			Roofing Panels	2.1	G												
			SD-03 Product Data														
			Roofing Panels	2.1	G												
			Energy Star Label for Aluminum	2.1.1	S												
			Roofing Product														
			Recycled Content of Aluminum	2.1.1	S												
			Roofing Products														
			Closures	2.2.1													
			Accessories	2.2													
			Warranty	1.8	G												
			SD-04 Samples														
			Roofing Panels	2.1													
			Accessories	2.2													
			SD-05 Design Data														
			Load Calculations	1.5	G												
			SD-06 Test Reports														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/E REVIEW WR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		07 61 15.00 20	Structural Performance	1.3.2.5	G												
			Panel Finish	1.6.6	G												
			Manufacturer's Field Inspection	3.5	G												
			SD-07 Certificates														
			Technical Representative	1.6.2													
			Qualification of Installer	1.6.3													
			Coil Stock	2.1.1.5	G												
			SD-08 Manufacturer's Instructions														
			Sealant	2.2.3													
			Installation	3.3	G												
			SD-11 Closeout Submittals														
			Information Card	3.7													
			Warranty	1.8													
		07 84 00	SD-02 Shop Drawings														
			Firestopping System	2.1	G												
			SD-03 Product Data														
			Firestopping Materials	2.2	G												
			SD-06 Test Reports														
			Inspection	3.3	G												
			SD-07 Certificates														
			Inspector Qualifications	1.5.2													
			Firestopping Materials	2.2													
			Installer Qualifications	1.5.1	G												
		07 92 00	SD-03 Product Data														
			Sealants	2.1	G												
			Primers	2.2	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION OR REVIEW	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		07 92 00	Bond Breakers	2.3	G												
			Backstops	2.4	G												
			Field Adhesion	3.1	G												
			SD-07 Certificates														
			Indoor Air Quality For Interior Sealants	2.1.1	S												
			Indoor Air Quality For Interior Floor Joint Sealants	2.1.3	S												
			Indoor Air Quality For Interior Acoustical Sealants	2.1.4	S												
		08 11 13	SD-02 Shop Drawings														
			Doors	2.1	G												
			Doors	2.1	G												
			Frames	2.4	G												
			Frames	2.4	G												
			Accessories	2.2													
			SD-03 Product Data														
			Doors	2.1	G												
			Recycled Content for Steel Door Product	2.1	S												
			Frames	2.4	G												
			Recycled Content for Steel Frame Product	2.4	S												
			Accessories	2.2													
		08 14 00	SD-02 Shop Drawings														
			Doors	2.1	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION REVIEW OR E W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		08 14 00	SD-03 Product Data														
			Doors	2.1	G												
			Recycled Content for Door Cores	2.1.1.1	S												
			Accessories	2.2													
			Water-resistant Sealer	2.3.5													
			Warranty	1.5													
			Sound Transmission Class	2.1.2	G												
			Rating														
			Fire Resistance Rating	2.1.3	G												
			SD-04 Samples														
			Door Finish Color	2.3.4.1	G												
			SD-06 Test Reports														
			Cycle-Slam	2.4													
			Hinge Loading Resistance	2.4													
			SD-07 Certificates														
			Certificates of Grade	1.3.1													
			Certified Sustainably Harvested	2.1.1	S												
			Flush Wood Doors														
			Indoor Air Quality for	2.1.1.1	S												
			Particleboard and Agrifiber Door														
			Cores														
			SD-11 Closeout Submittals														
			Warranty	1.5													
		08 34 73	SD-02 Shop Drawings														
			Fabrication Drawings	2.1													
			SD-03 Product Data														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		08 34 73	Wood Sound Retardant Doors	2.1	G												
			Door Frames	2.1	G												
			Door Hardware	2.1	G												
			Door Frame Sound Infill	2.3.2	G												
			Vision Panels	2.1	G												
			Intumescent Seals and Gasketing	2.1	G												
			Thresholds	2.1	G												
			SD-06 Test Reports														
			Acoustical Tests	2.4.4	G												
			Air Infiltration Tests	2.4.4	G												
			Positive Pressure Tests	2.4.4	G												
			SD-07 Certificates														
			Wood Sound Retardant Doors	2.1	G												
			Door Frames	2.1	G												
			Door Hardware	2.1	G												
			Vision Panels	2.1	G												
			Intumescent Seals,Gasketing and	1.3.1.2	G												
			Door Bottoms														
			Thresholds	2.1	G												
			Assembly Test Reports	3.3.1													
		08 41 13	SD-02 Shop Drawings														
			Installation Drawings	3.3	G												
			Fabrication Drawings	2.2	G												
			SD-03 Product Data														
			Finish	2.2.3	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		08 41 13	Recycled Content of Aluminum Material	2.1.1.2	S												
			SD-06 Test Reports														
			Deflection	3.4.3													
			Air Infiltration	3.4.1													
			Condensation Resistance and Thermal Transmittance	3.4.4													
			Water Infiltration	3.4.5													
			SD-08 Manufacturer's Instructions														
			Manufacturer's Instructions	3.3													
			SD-11 Closeout Submittals														
			Manufacturer's Product Warranty	3.6													
		08 51 13	SD-02 Shop Drawings														
			Windows	2.1	G												
			Fabrication Drawings	1.6													
			SD-03 Product Data														
			Windows	2.1	G												
			Recycled Content of Aluminum Windows	2.1	S												
			Hardware	2.2.7.1	G												
			Fasteners	2.2.2	G												
			Window Performance	1.7	G												
			Thermal-Barrier Windows	2.3	G												
			Mullions	2.4	G												
			Screens	2.2.9	G												
			Weatherstripping	2.1.4	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		08 51 13	Accessories	2.2.7	G												
			Adhesives	2.2.3													
			Thermal Performance	1.7.4	G												
			SD-04 Samples														
			Finish Sample	1.3.4.1													
			Window Sample	1.3.4.2													
			SD-05 Design Data														
			Structural Calculations for	2.1	G												
			Deflection														
			Design Analysis	1.3.5	G												
			SD-06 Test Reports														
			Minimum Condensation	1.3.6													
			Resistance Factor														
			SD-07 Certificates														
			Engineer's Qualifications	1.3.5													
			SD-10 Operation and Maintenance														
			Data														
			Windows	2.1	G												
		08 71 00	SD-02 Shop Drawings														
			Manufacturer's Detail Drawings	1.3	G												
			Verification of Existing Conditions	1.3	G												
			Hardware Schedule	1.5	G												
			Keying System	2.3.6	G												
			SD-03 Product Data														
			Hardware Items	2.3	G												
			SD-08 Manufacturer's Instructions														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/E REVIEW WR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		08 71 00	Installation	3.1													
			SD-10 Operation and Maintenance Data														
			Hardware Schedule	1.5	G												
			SD-11 Closeout Submittals														
			Key Bitting	1.6.1													
		08 81 00	SD-03 Product Data														
			Insulating Glass	2.3													
			Glazing Accessories	1.3													
			Sealants	2.4.1.1													
			Joint Backer	2.4.2													
			SD-04 Samples														
			Insulating Glass	2.3													
			Tape	2.4.4													
			Sealing Tapes	2.4.4													
			SD-08 Manufacturer's Instructions														
			Setting and Sealing Materials	2.4													
			Glass Setting	3.2													
			SD-11 Closeout Submittals														
			Insulated Glass Units	1.7.1													
		08 91 00	SD-02 Shop Drawings														
			Wall Louvers	1.4													
			SD-03 Product Data														
			Metal Wall Louvers	2.2													
			SD-04 Samples														
			Wall Louver Samples	1.5	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
RR1 Repair by Replacement																	
ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		09 22 00	SD-03 Product Data														
			Metal Support Systems	2.1													
			Recycled Content for Metal Support Systems	2.1	S												
		09 29 00	SD-03 Product Data														
			Cementitious Backer Units	2.1.3													
			Abuse Resistant Gypsum Board	2.1.2													
			Accessories	2.1.6													
			Gypsum Board	2.1.1													
			Recycled Content for Gypsum Board	2.1.1	S												
			Recycled Content for Paper Facing and Gypsum Cores	2.1.1	S												
			VOC Content of Joint Compound	2.1.4	S												
			SD-07 Certificates														
			Asbestos Free Materials	2.1	G												
			Indoor Air Quality for Gypsum Board	2.1.1	S												
			SD-08 Manufacturer's Instructions														
			Safety Data Sheets	2.1													
			SD-10 Operation and Maintenance Data														
			Manufacturer Maintenance Instructions	2.1													
		09 30 10	SD-02 Shop Drawings														
			Detail Drawings	3.2	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N A / E R E V I O W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		09 30 10	SD-03 Product Data														
			Porcelain Tile	2.1.1	G												
			Recycled Content for Porcelain Tile	2.1.1													
			Setting-Bed	2.2	G												
			Mortar, Grout, and Adhesive	2.4	G												
			SD-04 Samples														
			Tile	2.1	G												
			Accessories	2.1	G												
			Transition Strips	2.1	G												
			Transition Strips	2.5	G												
			Grout	2.4	G												
			SD-07 Certificates														
			Indoor Air Quality for Adhesives	2.4													
			Indoor Air Quality for Sealants	2.4.4													
			SD-08 Manufacturer's Instructions														
			Maintenance Instructions	3.7													
			SD-10 Operation and Maintenance Data														
			Installation	3.2	G												
		09 51 00	SD-02 Shop Drawings														
			Approved Detail Drawings	2.1	G												
			SD-03 Product Data														
			Acoustical Ceiling Systems	1.8	G												
			Recycled Content For Type III Ceiling Tiles	2.3.1.1													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/E REVIEW WR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		09 51 00	Recycled Content For Type III Ceiling Tiles	2.3.2.1													
			SD-04 Samples														
			Acoustical Units	2.3	G												
			Acoustical Ceiling Tiles	2.3.1.1	G												
			SD-06 Test Reports														
			Ceiling Attenuation Class and Test (ACT-1)	2.1.1	G												
			Ceiling Attenuation Class and Test (ACT-2)	2.2													
			SD-07 Certificates														
			Indoor Air Quality for Type VII Ceiling Tiles	2.3.3.1	S												
			Indoor Air Quality for Sealants	2.9													
			Indoor Air Quality For Type III Ceiling Tiles	2.3.1.1													
			Indoor Air Quality For Type III Ceiling Tiles	2.3.2.1													
		09 65 00	SD-02 Shop Drawings														
			Resilient Flooring and Accessories	2.7	G												
			SD-03 Product Data														
			Resilient Flooring and Accessories	2.7	G												
			Adhesives	2.3													
			Wall Base	2.1													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		09 65 00	SD-04 Samples														
			Resilient Flooring and Accessories	2.7	G												
			SD-06 Test Reports														
			Moisture, Alkalinity and Bond Tests	3.3	G												
			SD-07 Certificates														
			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												
			Installation	3.1	G												
			SD-10 Operation and Maintenance Data														
			Resilient Flooring and Accessories	2.7	G												
		09 67 23.13	SD-02 Shop Drawings														
			Installation Drawings	2.1	G												
			Fabrication Drawings	2.1	G												
			SD-03 Product Data														
			Manufacturer's Catalog Data	1.1.2	G												
			SD-04 Samples														
			Hardboard Mounted Epoxy Flooring	1.4.2	G												
			SD-05 Design Data														
			Design Mix Data	1.1.3	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIFI CATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		09 67 23.13	SD-07 Certificates														
			Listing of Product Installations	1.4.1													
			Referenced Standards	1.4													
			Certificates														
			SD-11 Closeout Submittals														
			Warranty	1.5	G												
		09 68 00	SD-02 Shop Drawings														
			Installation Drawings	3.4	G												
			SD-03 Product Data														
			Carpet	2.1	G												
			Carpet Cushion	2.3	G												
			Recycled Content for Carpeting	2.1.1													
			Recycled Content for	2.3.1													
			Polyurethane-Foam Cushion														
			Moldings	2.5	G												
			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														
			SD-04 Samples														
			Carpet	2.1	G												
			Moldings	2.5	G												
			Carpet Cushion	2.3	G												
			SD-06 Test Reports														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		09 68 00	Moisture and Alkalinity Tests	3.2	G												
			SD-07 Certificates														
			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-03 Product Data														
			Coating	2.1	G												
			Product Data Sheets	2.1													
			SD-04 Samples														
			Color	2.2	G												
			SD-07 Certificates														
			Indoor Air Quality for Paints and	1.6.4													
			Primers														
			SD-08 Manufacturer's Instructions														
			Mixing	2.1													
			Manufacturer's Safety Data	1.8.1													
			Sheets														
			SD-10 Operation and Maintenance														
			Data														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/E REVIEW WR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		09 90 00	Coatings	2.1	G												
		10 14 00.20	SD-02 Shop Drawings														
			Detail Drawings	1.4.2	G												
			SD-03 Product Data														
			Installation	3.1	G												
			Warranty	1.6	G												
			SD-04 Samples														
			Interior Signage	1.4.1	G												
			Software	1.3	G												
			SD-10 Operation and Maintenance Data														
			Approved Manufacturer's Instructions	3.1	G												
			Protection and Cleaning	3.1.2	G												
		10 21 13	SD-02 Shop Drawings														
			Fabrication Drawings	2.1													
			Installation Drawings	3.2	G												
			SD-03 Product Data														
			Cleaning and Maintenance Instructions	2.1													
			Colors And Finishes	2.7													
			Anchoring Devices and Fasteners	2.2.2													
			Hardware and Fittings	2.2.4													
			Brackets	2.2.3													
			Door Hardware	2.2.5													
			Toilet Enclosures	2.3.1													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		10 21 13	Urinal Screens	2.3.2													
			Pilaster Shoes	2.5													
			Finishes	2.2.4.2	G												
			Finishes	2.7.2	G												
			SD-04 Samples														
			Colors and Finishes	2.7	G												
			Hardware and Fittings	2.2.4													
			Anchoring Devices and Fasteners	2.2.2													
			SD-07 Certificates														
			Warranty	1.6													
			SD-10 Operation and Maintenance														
			Data														
			Plastic Identification	2.1.1	G												
		10 26 00	SD-02 Shop Drawings														
			Corner Guards	2.2	G												
			SD-03 Product Data														
			Corner Guards	2.2	G												
			SD-04 Samples														
			Finish	2.4	G												
			SD-06 Test Reports														
			Corner Guards	2.2													
			SD-07 Certificates														
			Corner Guards	2.2													
			Indoor air quality for adhesives	2.5													
		10 28 13	SD-02 Shop Drawings														
			Product Schedule	2.1													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
RR1 Repair by Replacement																	
ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION OR REVIEW	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		10 28 13	SD-03 Product Data														
			Recycled content for stainless steel toilet accessories	2.1	S												
			Paper Towel Dispenser (PTD)	2.1.3	G												
			Sanitary Napkin Disposal (SND)	2.1.4	G												
			Grab Bar (GB36) (GB42)	2.1.5	G												
			Shelf, Mop and Broom Holder (MHS)	2.1.6	G												
			Robe Hook (RH)	2.1.7	G												
			Shower Curtain Rod (SCR)	2.1.8	G												
			Toilet Tissue Dispenser (TTD)	2.1.9	G												
			Wall Mirror (WM)	2.1.10	G												
			Foam Soap Dispenser (SD)	2.1.11	G												
			Semi Recessed Waste	2.1.12	G												
			Receptacle and Paper Towel Dispenser (ITDW)														
			SD-10 Operation and Maintenance Data														
			Paper Towel Dispenser (PTD)	2.1.3													
			Sanitary Napkin Disposal (SND)	2.1.4													
			Grab Bar (GB36) (GB42)	2.1.5													
			Shelf, Mop and Broom Holder (MHS)	2.1.6													
			Robe Hook (RH)	2.1.7													
			Shower Curtain Rod (SCR)	2.1.8													
			Toilet Tissue Dispenser (TTD)	2.1.9													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/E REVIEW WR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		10 28 13	Wall Mirror (WM)	2.1.10													
			Foam Soap Dispenser (SD)	2.1.11	G												
			Semi Recessed Waste	2.1.12													
			Receptacle and Paper Towel Dispenser (ITDW)														
		10 44 16	SD-02 Shop Drawings														
			Cabinets	Part 2	G												
			Wall Brackets	2.1.2	G												
			SD-03 Product Data														
			Accessories	Part 2	G												
			Cabinets	Part 2	G												
			Wall Brackets	2.1.2	G												
			Replacement Parts List	3.2.1	G												
			SD-04 Samples														
			Equipment Samples	1.3.1	G												
		12 24 13	SD-02 Shop Drawings														
			Installation	3.2	G												
			SD-03 Product Data														
			Window Shades	2.1	G												
			Recycled Content for various fiber components	2.1													
			SD-04 Samples														
			Window Shades	2.1	G												
			SD-06 Test Reports														
			Window Shades	2.1													
			SD-07 Certificates														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		12 24 13	Indoor Air Quality for roller window shades	2.1													
			SD-08 Manufacturer's Instructions Window Shades	2.1													
			SD-10 Operation and Maintenance Data														
			Window Shades	2.1													
			SD-11 Closeout Submittals														
			Warranty	1.7	G												
		21 13 13	SD-01 Preconstruction Submittals														
			Qualified Fire Protection Engineer (QFPE)	1.2.3	G												
			Sprinkler System Designer	1.4.2.1	G												
			Sprinkler System Installer	1.4.2.2	G												
			SD-02 Shop Drawings														
			Shop Drawing	1.2.1.1	G												
			SD-03 Product Data														
			Pipe	2.2.1	G												
			Fittings	2.3.1.2	G												
			Valves	2.3.4	G												
			Relief Valves	2.8.5	G												
			Sprinklers	2.7	G												
			Pipe Hangers and Supports	2.3.3	G												
			Sprinkler Alarm Switch	2.4.1	G												
			Valve Supervisory (Tamper)	2.4.2	G												
			Switch														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION REVIEWER	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		21 13 13	Fire Department Connection	2.6	G												
			Backflow Prevention Assembly	2.5	G												
			Air Vent	2.8.6	G												
			Hose Valve	2.5.1	G												
			Nameplates	2.1.2	G												
			SD-05 Design Data														
			Hydraulic Calculations	1.2.1.2	G												
			SD-06 Test Reports														
			Test Procedures	3.7.1	G												
			SD-07 Certificates														
			Verification of Compliant	3.7.2.1	G												
			Installation														
			Request for Government Final	3.7.2.2	G												
			Test														
			SD-10 Operation and Maintenance														
			Data														
			Operating and Maintenance	3.9	G												
			(O&M) Instructions														
			Spare Parts	1.6	G												
			SD-11 Closeout Submittals														
			As-built drawings	3.9													
		22 00 00	SD-03 Product Data														
			Fixtures	2.4													
			Flush Valve Water Closets	2.4.2													
			WaterSense Label for Flush	2.4.2	S												
			Valve Water Closet														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/ REV W	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		22 00 00	Flush Valve Urinals	2.4.3													
			WaterSense Label for Urinal	2.4.3	S												
			Wall Hung Lavatories	2.4.4													
			Precast Terrazzo Mop Sinks	2.4.6													
			Energy Star Label for Wheelchair	2.4.5	S												
			Electric Water Cooler														
			Water Heaters	2.8	G												
			Pumps	2.9	G												
			SD-06 Test Reports														
			Tests, Flushing and Disinfection	3.7													
			Materials and Equipment	1.3													
			SD-10 Operation and Maintenance														
			Data														
			Plumbing System	3.7.1	G												
		23 05 48.19	SD-02 Shop Drawings														
			Coupling and Bracing	3.1													
			Flexible Couplings or Joints	3.3													
			Equipment Restraint	2.2													
			Contractor Designed Bracing	1.2.4	G												
			SD-03 Product Data														
			Coupling and Bracing	3.1	G												
			Flexible Couplings Or Joints	3.3	G												
			Equipment Restraint	2.2	G												
			Contractor Designed Bracing	1.2.4	G												
			Snubbers	2.6													
			Anchor Bolts	3.9													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 05 48.19	Vibration Isolators	2.2.2													
			SD-05 Design Data														
			Design Calculations	1.2.4													
			SD-06 Test Reports														
			Anchor Bolts	3.9	G												
		23 05 93	SD-01 Preconstruction Submittals														
			Records of Existing Conditions	1.3.3	G												
			Independent TAB Agency and Personnel Qualifications	1.5.1	G												
			TAB Design Review Report	1.5.3.1	G												
			SD-02 Shop Drawings														
			TAB Schematic Drawings and Report Forms	1.3.3	G												
			SD-03 Product Data														
			Equipment and Performance Data	1.3	G												
			TAB Related HVAC Submittals	1.5.1.3	G												
			SD-06 Test Reports														
			Completed Pre-Final DALT Report	3.3.5	G												
			Certified Final DALT Report	3.3.8	G												
			Prerequisite HVAC Work Checkout List	1.5.3.2	G												
			Prerequisite HVAC Work Checkout List	1.5.3.2	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION REVIEW OR A/E	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 05 93	Prerequisite HVAC Work	1.5.3.2	G												
			Checkout List														
			Proportional Balancing	3.4.5.1	G												
			Proportional Balancing	3.7	G												
			Season 1	3.4.5.2	G												
			Season 1	3.7	G												
			Season 2	3.4.5.2	G												
			Season 2	3.7	G												
			SD-07 Certificates														
			Independent TAB Agency and Personnel Qualifications	1.5.1	G												
			DALT and TAB Submittal and Work Schedule	1.5.3.1	G												
			TAB Pre-Field Engineering Report	1.5.3.2	G												
			Instrument Calibration Certificates	1.5.5	G												
			DALT and TAB Procedures Summary	3.7	G												
			Completed Pre-Final DALT Work Checklist	3.7	G												
			Advance Notice of Pre-Final DALT Field Work	3.3.2	G												
			Proportional Balancing	3.4.5.1	G												
			Proportional Balancing	3.7	G												
			Season 1	3.4.5.2	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 05 93	Season 1	3.7	G												
			Season 2	3.4.5.2	G												
			Season 2	3.7	G												
		23 07 00	SD-02 Shop Drawings														
			MICA Plates	3.2.2.4	G												
			Pipe Insulation Systems	2.3													
			Pipe Insulation Systems	3.2													
			Duct Insulation Systems	3.3													
			Equipment Insulation Systems	3.4													
			Recycled content for insulation materials	2.3.1	S												
			SD-03 Product Data														
			Pipe Insulation Systems	2.3	G												
			Pipe Insulation Systems	3.2	G												
			Duct Insulation Systems	3.3	G												
			Equipment Insulation Systems	3.4	G												
			SD-07 Certificates														
			Indoor air quality for adhesives	2.2.1	S												
			SD-08 Manufacturer's Instructions														
			Pipe Insulation Systems	2.3	G												
			Pipe Insulation Systems	3.2	G												
			Duct Insulation Systems	3.3	G												
			Equipment Insulation Systems	3.4	G												
		23 09 23.13	SD-02 Shop Drawings														
			Control System Drawings Title Sheet	1.4.1.1	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N OR A / E R E V I W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 09 23.13	List of I/O Points	1.4.1.2	G												
			Control System Components List	1.4.1.3	G												
			Control System Schematics	1.4.1.4	G												
			HVAC Equipment Control Ladder Diagrams	1.4.1.5	G												
			Component Wiring Diagrams	1.4.1.6	G												
			Terminal Strip Diagrams	1.4.1.7	G												
			BACnet Communication	1.4.1.8													
			Architecture Schematic (Network Riser)														
			Sequence of Operations	1.4.1.4													
			Control Panel Layout	1.4.1.9													
			SD-03 Product Data														
			Direct Digital Controllers	2.1.3	G												
			BACnet Gateways	2.1.3.12	G												
			Notebook Computer Software	2.1.6	G												
			Notebook Computer	2.1.5	G												
			Sensors and Input Hardware	2.2	G												
			Output Hardware	2.3	G												
			Surge and Transient Protection	2.4.2	G												
			Indicators	2.6	G												
			Duct smoke detectors	2.5.1	G												
			Variable Frequency (Motor) Drives	2.7	G												
			SD-05 Design Data														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N O R A / E R E V I O W N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 09 23.13	Performance Verification Testing Plan	3.5.5	G												
			Pre-Performance Verification Testing Checklist	3.5.7	G												
			SD-06 Test Reports														
			Performance Verification Testing Report	3.5.14	G												
			Bus Waveform Report	3.5.15	G												
			SD-07 Certificates														
			Contractor's Qualifications	1.6.6	G												
			Contractor's Training Certifications	3.6.1	G												
			SD-10 Operation and Maintenance Data														
			BACnet Direct Digital Control Systems	1.4	G												
			Controls System Operators Manuals	3.4	G												
			VFD Service Manuals	2.7.2	G												
			SD-11 Closeout Submittals														
			Training Documentation	3.6.1	G												
			Warranty Information	3.4	G												
		23 11 20	SD-02 Shop Drawings														
			Gas Piping System	1.5.1	G												
			Gas Piping System	2.2	G												
			Gas Piping System	3.2	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/E REVIEW WR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 11 20	SD-03 Product Data														
			Pipe and Fittings	2.1	G												
			Gas Equipment Connectors	1.5.1	G												
			Gas Piping System	1.5.1	G												
			Gas Piping System	2.2	G												
			Gas Piping System	3.2	G												
			Pressure Regulators	2.5	G												
			Valves	2.3	G												
			SD-06 Test Reports														
			Testing	3.17	G												
			Pressure Tests	3.17.1	G												
			Test with Gas	3.17.2	G												
			SD-10 Operation and Maintenance Data														
			Gas Facility System and Equipment Operation	1.3.1	G												
			Gas Facility System Maintenance	1.3.2	G												
			Gas Facility Equipment Maintenance	1.3.3	G												
		23 21 13.00 20	SD-02 Shop Drawings														
			Hot water heating system	1.3.1													
			SD-03 Product Data														
			Pumps	2.3.1													
			Expansion tanks	2.3.2													
			Flow measuring equipment	2.3.4													
			External air separation tanks	2.3.3													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 21 13.00 20	Hot water heating pipe	2.1.1													
			SD-06 Test Reports														
			Hydrostatic test of piping system	3.3.1													
			Auxiliary equipment and accessory tests	3.3.2													
			SD-07 Certificates														
			Backflow preventer certification	1.5.4													
			Report of prior installations	1.5.2.1													
			Welding procedures	1.5.2.2													
			Welder's qualifications	1.5.2.3													
		23 23 00	SD-02 Shop Drawings														
			Refrigerant Piping System	2.3	G												
			SD-03 Product Data														
			Refrigerant Piping System	2.3													
			Qualifications	1.3.1													
			Refrigerant Piping Tests	3.4													
			SD-06 Test Reports														
			Refrigerant Piping Tests	3.4													
			SD-07 Certificates														
			Service Organization	2.1													
			SD-10 Operation and Maintenance Data														
			Maintenance	1.5	G												
			Operation and Maintenance Manuals	3.3	G												
		23 25 00	SD-03 Product Data														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 25 00	Water Analysis	2.1.3	G												
			Spare Parts	1.3													
			Field Instructions	3.4.1													
			Tests	3.3.1	G												
			Training Course	3.4.1	G												
		23 30 00	SD-02 Shop Drawings														
			Detail Drawings	1.4.4	G												
			SD-03 Product Data														
			Insulated Nonmetallic Flexible Duct Runouts	2.8.1.1													
			Duct Connectors	2.8.1.1													
			Duct Access Doors	2.8.2	G												
			Fire Dampers	2.8.3													
			Manual Balancing Dampers	2.8.4	G												
			Diffusers	2.8.6.1													
			Registers and Grilles	2.8.6.2													
			Louvers	2.8.7													
			Centrifugal Fans	2.9.1.1													
			Panel Type Power Wall Ventilators	2.9.1.2													
			Air Handling Units	2.10	G												
			Room Fan-Coil Units	2.11.1	G												
			Energy Recovery Devices	2.12	G												
			Test Procedures	1.4.5													
			Diagrams	1.2.1.2	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 30 00	Indoor Air Quality for Duct Sealants	2.8.1													
			SD-06 Test Reports														
			Performance Tests	3.12													
			Damper Acceptance Test	3.10	G												
			SD-07 Certificates														
			Ozone Depleting Substances Technician Certification	1.4.3													
			SD-08 Manufacturer's Instructions														
			Manufacturer's Installation Instructions	3.2													
			Operation and Maintenance Training	3.14.2													
			SD-10 Operation and Maintenance Data														
			Operation and Maintenance Manuals	3.14.1	G												
			Fire Dampers	2.8.3	G												
			Manual Balancing Dampers	2.8.4	G												
			Centrifugal Fans	2.9.1.1	G												
			Panel Type Power Wall Ventilators	2.9.1.2	G												
			Air Handling Units	2.10	G												
			Room Fan-Coil Units	2.11.1	G												
			Energy Recovery Devices	2.12	G												
			SD-11 Closeout Submittals														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 30 00	Indoor Air Quality During Construction	3.13	S												
		23 52 43.00 20	SD-02 Shop Drawings														
			Fuel Train	1.3.2.2													
			Wiring Diagram	1.3.2.2													
			SD-03 Product Data														
			Boilers	2.1													
			Boiler Trim and Control Equipment	2.2													
			Stack, Breeching, and Supports	2.2.16													
			SD-06 Test Reports														
			Operational Tests	3.3.1													
			SD-07 Certificates														
			Boilers	2.1													
			Boiler Trim and Control Equipment	2.2													
			SD-08 Manufacturer's Instructions														
			Boilers	2.1													
			SD-10 Operation and Maintenance Data														
			Boilers	2.1													
			SD-11 Closeout Submittals														
			Boilers	2.1													
		23 64 10	SD-03 Product Data														
			Water Chiller	2.4	G												
			Verification of Dimensions	1.6.1													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/E REVIEW WR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 64 10	Factory Tests	2.8													
			System Performance Tests	3.6													
			Demonstrations	3.7													
			Refrigerant	2.5.1													
			Water Chiller - Field Acceptance	3.5.1													
			Test Plan														
			SD-06 Test Reports														
			Field Acceptance Testing	3.5													
			Water Chiller - Field Acceptance	3.5.2													
			Test Report														
			Factory Tests	2.8													
			System Performance Tests	3.6													
			SD-07 Certificates														
			Refrigeration System	3.1.8	G												
			Ozone Depleting Substances	1.3.1													
			Technician Certification														
			SD-08 Manufacturer's Instructions														
			Water Chiller - Installation	3.1	G												
			Instructions														
			SD-10 Operation and Maintenance														
			Data														
			Operation and Maintenance	3.7	G												
			Manuals														
			SD-11 Closeout Submittals														
			Indoor Air Quality During	3.4	S												
			Construction														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION REVIEWER	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 64 26	SD-03 Product Data														
			Calibrated Balancing Valves	2.3.8	G												
			Water Temperature Regulating Valves	2.3.9	G												
			Water Pressure Reducing Valve	2.3.10													
			Pressure Relief Valve	2.3.11													
			Combination Pressure and Temperature Relief Valves	2.3.12													
			Expansion Joints	2.4.9	G												
			Pumps	2.5	G												
			Combination Strainer and Pump Suction Diffuser	2.4.3													
			Expansion Tanks	2.6													
			Air Separator Tanks	2.7													
			Water Treatment Systems	2.8	G												
			SD-06 Test Reports														
			Piping Welds NDE Report	3.1.1.3													
			Pressure Tests Reports	3.4.2	G												
			SD-07 Certificates														
			Employer's Record Documents (For Welding)	3.1.1.1													
			Welding Procedures and Qualifications	3.1.1.2													
			SD-08 Manufacturer's Instructions														
			Lesson plan for the Instruction Course	3.5	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION OR REVIEW	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 64 26	SD-10 Operation and Maintenance Data														
			Water Treatment Systems	2.8	G												
			Calibrated Balancing Valves	2.3.8	G												
			Water Temperature Regulating Valves	2.3.9	G												
			Water Pressure Reducing Valve	2.3.10	G												
			Pressure Relief Valve	2.3.11	G												
			Combination Pressure and Temperature Relief Valves	2.3.12	G												
			Expansion Joints	2.4.9	G												
			Pumps	2.5	G												
			Combination Strainer and Pump Suction Diffuser	2.4.3	G												
			Expansion Tanks	2.6	G												
			Air Separator Tanks	2.7	G												
		23 81 00	SD-03 Product Data														
			Coil Corrosion Protection	2.5.1													
			Supplied Products	2.1													
			Manufacturer's Standard Catalog Data	2.2													
			SD-06 Test Reports														
			Refrigerant Tests, Charging, and Start-Up	3.4	G												
			System Performance Tests	3.5	G												
			SD-07 Certificates														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION OR REFERENCE NUMBER	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		23 81 00	Service Organizations	3.6.2													
			SD-11 Closeout Submittals														
			Ozone Depleting Substances	2.2.2.3	S												
		25 05 11	SD-01 Preconstruction Submittals														
			Wireless and Wired Broadcast	3.2.3.3	G												
			Communication Request														
			Device Account Lock Exception	3.3.2	G												
			Request														
			Multiple Ethernet Connection	3.2.5.2	G												
			Device Request														
			Contractor Computer	1.9.1.6	G												
			Cybersecurity Compliance														
			Statements														
			Contractor Temporary Network	1.9.6	G												
			Cybersecurity Compliance														
			Statements														
			Cybersecurity Interconnection	1.7.2	G												
			Schedule														
			Protection of Information At Rest	3.7.4	G												
			Proposal														
			Proposed STIG and SRG	1.7.1	G												
			Applicability Report														
			SD-02 Shop Drawings														
			Network Communication Report	1.7.3	G												
			Cybersecurity Riser Diagram	1.7.6	G												
			SD-03 Product Data														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N O R A / E R E V I O W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		25 05 11	Control System Cybersecurity Documentation	1.7.8	G												
			SD-06 Test Reports														
			Wireless Communication Test Report	3.2.3.4	G												
			Control System Cybersecurity Testing Procedures	3.14.1	G												
			Control System Cybersecurity Testing Report	3.14.3	G												
			SD-07 Certificates														
			Software Licenses	1.8	G												
			SD-11 Closeout Submittals														
			Password Change Summary Report	3.4.3.5	G												
			Enclosure Keys	3.3.7	G												
			Software and Configuration Backups	1.7.5	G												
			Auditing Front End Software	3.5.3	G												
			Device Audit Record Upload Software	3.5.4.2	G												
			System Maintenance Tool Software	3.9	G												
			Control System Scanning Tools	3.11.2	G												
			STIG, SRG and Vendor Guide Compliance Result Report	1.7.7	G												
			Control System Inventory Report	1.7.4	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION REVIEW OR A/E	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		25 05 11	Integrity Verification Software	3.13.2	G												
		26 08 00	SD-06 Test Reports														
			Acceptance Tests and Inspections	3.1	G												
			SD-07 Certificates														
			Qualifications	1.4.1	G												
			Acceptance Test and Inspections Procedure	1.4.3	G												
		26 12 19.10	SD-02 Shop Drawings														
			Pad-mounted Transformer Drawings	1.5.1	G												
			SD-03 Product Data														
			Pad-mounted Transformers	2.2	G												
			SD-06 Test Reports														
			Acceptance Checks and Tests	3.6.1	G												
			SD-07 Certificates														
			Transformer Efficiencies	2.2.2.1	G												
			SD-09 Manufacturer's Field Reports														
			Transformer Test Schedule	2.8.1	G												
			Design Tests	2.8.2	G												
			Routine and Other Tests	2.8.3	G												
			SD-10 Operation and Maintenance Data														
			Transformer(s)	1.6.1	G												
		26 20 00	SD-02 Shop Drawings														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		26 20 00	Panelboards	2.12	G												
			Cable Trays	2.3	G												
			SD-03 Product Data														
			Receptacles	2.11	G												
			Circuit Breakers	2.12.3	G												
			Switches	2.9	G												
			Enclosed Circuit Breakers	2.13	G												
			Manual Motor Starters	2.14	G												
			Secondary Bonding Busbar	2.17.2	G												
			Surge Protective Devices	2.22	G												
			Cable Trays	2.3	G												
			SD-06 Test Reports														
			600-volt Wiring Test	3.5.2	G												
			Grounding System Test	3.5.5	G												
			Ground-fault Receptacle Test	3.5.3	G												
			Arc-fault Receptacle Test	3.5.4	G												
			SD-07 Certificates														
			Fuses	2.10	G												
			SD-10 Operation and Maintenance Data														
			Electrical Systems	1.5.1	G												
		26 24 13	SD-02 Shop Drawings														
			Switchboard Drawings	1.5.2	G												
			SD-03 Product Data														
			Switchboard	2.2	G												
			SD-06 Test Reports														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		26 24 13	Switchboard Design Tests	2.5.2	G												
			Switchboard Production Tests	2.5.3	G												
			Acceptance Checks and Tests	3.5.1	G												
			SD-10 Operation and Maintenance Data														
			Switchboard Operation and Maintenance	1.6.1	G												
			SD-11 Closeout Submittals														
			Assembled Operation and Maintenance Manuals	1.6.2	G												
			Equipment Test Schedule	2.5.1	G												
			Required Settings	3.5	G												
			Service Entrance Available Fault Current Label	2.8	G												
		26 27 14.00 20	SD-02 Shop Drawings														
			Installation Drawings	1.3.1	G												
			SD-03 Product Data														
			Electricity Meters	2.1.4	G												
			Current Transformer	2.1.3	G												
			Potential Transformer	2.1.2	G												
			Communications	2.2	G												
			SD-06 Test Reports														
			Acceptance Checks and Tests	3.2.1	G												
			System Functional Verification	3.2.2	G												
			Building Meter Installation Sheet, per Building	3.2.1	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		26 27 14.00 20	Meter Configuration Template	2.1.1	G												
			Meter Configuration Report	3.2.1	G												
			SD-10 Operation and Maintenance Data														
			Electricity Meters and Accessories	1.4.1	G												
			SD-11 Closeout Submittals														
			System Functional Verification	3.2.2	G												
		26 28 01.00 10	SD-03 Product Data														
			Fault Current Analysis	2.1													
			Protective Device Coordination Study	2.1													
			System Coordinator	1.3.1													
		26 41 00	SD-02 Shop Drawings														
			Overall lightning protection system	1.4.1.1	G												
			Each major component	1.4.1.2	G												
			SD-06 Test Reports														
			Lightning Protection and Grounding System Test Plan	1.4.3	G												
			Lightning Protection and Grounding System Test	3.5.1	G												
			SD-07 Certificates														
			Lightning Protection System	1.2.3	G												
			Installers Documentation														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		26 41 00	Component UL Listed and Labeled	1.4.2	G												
			Lightning protection system inspection certificate	1.4.4	G												
			Roof manufacturer's warranty	3.1.1	G												
		26 51 00	SD-02 Shop Drawings														
			Luminaire Drawings	1.5.1	G												
			Lighting Control System One-Line Diagram	1.7.2	G												
			SD-03 Product Data														
			Luminaires	2.2	G												
			Light Sources	2.3	G												
			LED Drivers	2.4	G												
			Luminaire Warranty	1.6.1	G												
			Lighting Controls Warranty	1.6.2	G												
			Switches	2.5.1.1	G												
			Wall Box Dimmers	2.5.1.2	G												
			Occupancy/Vacancy Sensors	2.5.1.3	G												
			Time Clocks	2.5.1.4	G												
			Power Packs	2.5.1.3.2	G												
			Exit Signs	2.6.1	G												
			Emergency Drivers	2.6.3	G												
			SD-05 Design Data														
			Luminaire Design Data	1.5.2	G												
			SD-06 Test Reports														
			ANSI/IES LM-79 Test Report	1.5.3	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
RR1 Repair by Replacement																	
ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		26 51 00	ANSI/IES LM-80 Test Report	1.5.4	G												
			ANSI/IES TM-21 Test Report	1.5.5	G												
			ANSI/IES TM-30 Test Report	1.5.6	G												
			Occupancy/Vacancy Sensor	3.2.1.1	G												
			Verification Test														
			Photosensor Verification Test	3.2.1.1	G												
			SD-07 Certificates														
			LED Driver and Dimming Switch	1.5.7	G												
			Compatibility Certificate														
			SD-10 Operation and Maintenance														
			Data														
			Lighting System	1.7.1	G												
			Lighting Control System	1.7.2	G												
			End-User Training Plan	3.3.1.1	G												
		26 56 00	SD-02 Shop Drawings														
			Luminaire Drawings	1.5.1.1	G												
			Pole Drawings	1.5.1.2	G												
			SD-03 Product Data														
			Luminaires	2.2	G												
			Light Sources	2.3	G												
			LED Drivers	2.4	G												
			Luminaire Warranty	1.7.1	G												
			Lighting Controls Warranty	1.7.2	G												
			Pole Warranty	1.7.3	G												
			Photosensors	2.5.1.2	G												
			Time Clock	2.5.1.1	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N O R A / E R E V I W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		26 56 00	Lighting Contactor	2.5.1.3	G												
			Poles	2.6	G												
			Brackets	2.6.2													
			SD-05 Design Data														
			Luminaire Design Data	1.5.2	G												
			SD-06 Test Reports														
			ANSI/IES LM-79 Test Report	1.5.3	G												
			ANSI/IES LM-80 Test Report	1.5.4	G												
			ANSI/IES TM-21 Test Report	1.5.5	G												
			SD-08 Manufacturer's Instructions														
			Poles	2.6													
			SD-10 Operation and Maintenance														
			Data														
			Lighting System	1.8.1	G												
			End-User Training Plan	3.3.1.1	G												
		27 10 00	SD-02 Shop Drawings														
			Telecommunications Drawings	1.6.1.1	G												
			Telecommunications Space	1.6.1.2	G												
			Drawings														
			SD-03 Product Data														
			Telecommunications Cabling	2.3	G												
			Patch Panels	2.4.5	G												
			Telecommunications	2.5	G												
			Outlet/Connector Assemblies														
			Equipment Support Frame	2.4.2	G												
			Connector Blocks	2.4.3	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		27 10 00	SD-06 Test Reports														
			Telecommunications Cabling Testing	3.5.1	G												
			SD-07 Certificates														
			Telecommunications Contractor	1.6.2.1	G												
			Key Personnel	1.6.2.2	G												
			Manufacturer Qualifications	1.6.2.3	G												
			Test Plan	1.6.3	G												
			SD-09 Manufacturer's Field Reports														
			Factory Reel Tests	2.11.1	G												
			SD-10 Operation and Maintenance Data														
			Telecommunications Cabling and Pathway System	1.10.1	G												
			SD-11 Closeout Submittals														
			Record Documentation	1.10.2	G												
		28 31 76	SD-01 Preconstruction Submittals														
			Qualified Fire Protection Engineer (QFPE)	1.3.2	G												
			Fire alarm system designer	1.9.2.1	G												
			Supervisor	1.9.2.2	G												
			Technician	1.9.2.3	G												
			Installer	1.9.2.4	G												
			Test Technician	1.9.2.5	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N O R A / E R E V I W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		28 31 76	Fire Alarm System Site-Specific Software Acknowledgement	1.7	G												
			SD-02 Shop Drawings														
			Nameplates	1.9.1.3	G												
			Instructions	2.2.4	G												
			Wiring Diagrams	1.9.1.4	G												
			System Layout	1.9.1.5	G												
			Notification Appliances	1.9.1.6	G												
			Initiating devices	1.9.1.7	G												
			Amplifiers	1.9.1.8	G												
			Battery Power	1.9.1.9	G												
			Voltage Drop Calculations	1.9.1.10	G												
			SD-03 Product Data														
			Fire Alarm and Mass Notification Control Unit (FMCU)	2.3	G												
			Local Operating Console (LOC)	1.4.4	G												
			Amplifiers	1.9.1.8	G												
			Tone Generators	2.5	G												
			Digitalized voice generators	2.5	G												
			LCD Annunciator	2.6.1	G												
			Manual Stations	2.7	G												
			Smoke Detectors	2.8	G												
			Duct Smoke Detectors	2.8.2	G												
			Carbon monoxide detector	2.9	G												
			Addressable Interface Devices	2.10	G												
			Addressable Control Modules	2.11	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N A / E R E V I W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		28 31 76	Notification Appliances	1.9.1.6	G												
			Batteries	2.14.1	G												
			Battery Chargers	2.14.2	G												
			Supplemental Notification Appliance Circuit Panels	2.14.1.1	G												
			Auxiliary Power Supply Panels	2.14.1.1	G												
			Surge Protective Devices	2.15	G												
			Alarm Wiring	2.15	G												
			Back Boxes and Conduit	3.3.4	G												
			Ceiling Bridges	3.2.9	G												
			Terminal Cabinets	3.3.2	G												
			Digital Alarm Communicator	2.18.1	G												
			Transmitter (DACT; Mass Notification Transceiver	2.17.1	G												
			Environmental Enclosures or Guards	2.20	G												
			Document Storage Cabinet	3.11.3	G												
			SD-06 Test Reports														
			Test Procedures	3.7.1	G												
			SD-07 Certificates														
			Verification of Compliant Installation	3.7.2.1	G												
			Request for Government Final Test	3.7.2.2	G												
			SD-10 Operation and Maintenance Data														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N O R A / E R E V I O W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		28 31 76	Operation and Maintenance (O&M) Instructions	3.9	G												
			Instruction of Government Employees	3.10	G												
			SD-11 Closeout Submittals														
			As-Built Drawings	1.9.1.13													
			Spare Parts	1.11.1													
		31 11 00	SD-03 Product Data														
			Tree Wound Paint	2.1.1													
		31 23 00.00 20	SD-01 Preconstruction Submittals														
			Shoring and Sheeting Plan	1.7.1													
			Dewatering work plan	1.7.2													
			SD-06 Test Reports														
			Borrow Site Testing	1.6	G												
			Fill and backfill	3.12.2.1													
			Select material	3.12.2.2	G												
			Porous fill	3.12.2.3	G												
			Density tests	3.12.2.4	G												
			Moisture Content Tests	3.12.2.5													
		31 31 16.13	SD-01 Preconstruction Submittals														
			Termiticide Application Plan	3.1.5	G												
			SD-03 Product Data														
			Termiticides	2.2.1													
			SD-05 Design Data														
			Mixing Formulation	3.2.2													
			SD-06 Test Reports														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
RR1 Repair by Replacement																	
ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION OR A/ REV W	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		31 31 16.13	Soil Moisture	1.6.1													
			Calibration Test	3.2.1													
			SD-07 Certificates														
			Qualifications	1.4.2	G												
			Foundation Exterior	3.1.2													
			Utilities and Vents	3.1.3													
			Crawl and Plenum Air Spaces	3.1.4													
			List of Equipment	3.2.1													
			SD-08 Manufacturer's Instructions														
			Termiticides	2.2.1													
			SD-11 Closeout Submittals														
			Verification of Measurement	3.3.1													
			Warranty	1.7													
			Pest Management Report	3.4													
		32 11 23	SD-03 Product Data														
			Plant, Equipment, and Tools	2.3	G												
			SD-06 Test Reports														
			Initial Tests	2.2.1	G												
			In-Place Tests	3.13.1	G												
		32 11 26	SD-03 Product Data														
			Sources of Aggregates	1.3.4	G												
			Job Mix Formula	2.3.2	G												
			SD-06 Test Reports														
			Sources of Aggregates	1.3.4													
			Bituminous Materials	1.3.6	G												
			Bituminous Materials	2.2	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		32 11 26	Test Section	2.3.2													
			Service Record	1.3.4													
			SD-09 Manufacturer's Field Reports														
			Batch Tickets	1.3.3													
		32 17 23	SD-03 Product Data														
			Surface Preparation Equipment List	2.1.1.1	G												
			Application Equipment List	2.1.2	G												
			Exterior Surface Preparation	3.2													
			Safety Data Sheets	1.3.1	G												
			Waterborne Paint	2.2.1	G												
			SD-06 Test Reports														
			Waterborne Paint	2.2.1	G												
			SD-07 Certificates														
			Qualifications	1.3.2	G												
			Waterborne Paint	2.2.1													
			Volatile Organic Compound	1.3.1	G												
			SD-08 Manufacturer's Instructions														
			Waterborne Paint	2.2.1	G												
		32 31 13.53	SD-02 Shop Drawings														
			Fence Installation Drawings	3.2.1	G												
			SD-03 Product Data														
			Posts	2.1.2.1	G												
			Sleeves	3.2.3.2	G												
			Latches	3.2.4	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		32 31 13.53	Hinges	2.1.2.1	G												
			Stops	3.2.4	G												
			Keepers	3.2.4	G												
			Ornamental Fence Systems	2.1.1	G												
			Swing Gates	2.1.2.1	G												
			SD-07 Certificates														
			Gate Hardware and Accessories	3.2.1	G												
			Concrete	2.2.1													
		32 92 23	SD-03 Product Data														
			Fertilizer	2.4													
			SD-06 Test Reports														
			Topsoil composition tests	2.2.3													
			SD-07 Certificates														
			sods	2.1													
		33 11 00	SD-01 Preconstruction Submittals														
			Connections	3.1.1	G												
			SD-03 Product Data														
			Pipe, Fittings, Joints and	2.1.1	G												
			Couplings														
			Valves	2.1.2	G												
			Valve Boxes	2.1.2.5	G												
			Fire Hydrants	2.1.3.1	G												
			Pipe Restraint	2.2.1	G												
			Tapping Sleeves	2.2.2	G												
			Corporation Stops	2.2.7.1	G												
			Backflow Preventer	1.4.2.1.1	G												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS SIF CATION REVIEW OR E	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		33 11 00	Disinfection Procedures	3.2.4	G												
			SD-06 Test Reports														
			Backflow Preventer Tests	3.3.1.5	G												
			Bacteriological Samples	3.3.1.4	G												
			Leakage Test	3.3.1.3	G												
			Hydrostatic Test	3.3.1.1	G												
			SD-07 Certificates														
			Pipe, Fittings, Joints and Couplings	2.1.1	G												
			Lining	2.1.1.1.1	G												
			Lining	2.1.1.1.1	G												
			Lining for Fittings	2.1.1.2.1	G												
			Valves	2.1.2	G												
			Fire Hydrants	2.1.3.1	G												
			Backflow Prevention Training Certificate	1.4.2.1.1	G												
			Backflow Tester	1.4.2.1.1	G												
			SD-08 Manufacturer's Instructions														
			Ductile-Iron Piping	2.1.1.1	G												
			PVC Piping	2.1.1.2.1	G												
			PVC Piping For Service Lines	2.1.1.2.2	G												
		33 30 00	SD-01 Preconstruction Submittals														
			Contractor's License	1.3.1	G												
			SD-02 Shop Drawings														
			Installation Drawings	3.1.1	G												
			SD-03 Product Data														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N O R A / E R E V W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		33 30 00	Gravity Pipe	2.2.1	G												
			SD-06 Test Reports														
			Hydrostatic Sewer Test	3.3.1.1	G												
			Low-Pressure Air Tests	3.3.1.2.1	G												
			SD-07 Certificates														
			Portland Cement	2.2.2													
		33 40 00	SD-03 Product Data														
			Pipe	2.1	G												
			Placing Pipe	3.3	G												
			SD-06 Test Reports														
			Hydrostatic Test on Watertight Joints	2.4.1	G												
		33 71 01	SD-03 Product Data														
			Conductors	2.5	G												
			Insulators	2.4	G												
			Cutouts	2.8	G												
			Surge Arresters	2.7	G												
			SD-06 Test Reports														
			Field Quality Control	3.4	G												
			Ground Resistance Test Reports	1.5.3	G												
			Medium-Voltage Preassembled Cable Test	3.4.3	G												
			Sag and Tension Test	3.4.4	G												
			Acceptance Checks and Tests	3.4.6													
			SD-09 Manufacturer's Field Reports														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASS S I F I C A T I O N O R A / E R E V I W R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		33 71 01	Operation and Maintenance Manuals	1.6	G												
			Operation and Maintenance Manuals	1.6.1	G												
			SD-10 Operation and Maintenance Data														
			Operation and Maintenance Manuals	1.6	G												
			Operation and Maintenance Manuals	1.6.1	G												
		33 71 02	SD-03 Product Data														
			Medium Voltage Cable	2.5	G												
			Medium Voltage Cable Joints	2.7	G												
			Medium Voltage Cable Terminations	2.6	G												
			Live End Caps	2.9	G												
			SD-06 Test Reports														
			Medium Voltage Cable	2.13.2	G												
			Qualification and Production Tests														
			Field Acceptance Checks and Tests	3.16.1	G												
			Arc-proofing Test	2.13.1	G												
			SD-07 Certificates														
			Cable splicer/terminator	1.5.1	G												
			Cable Installer Qualifications	1.5.2	G												
		33 82 00	SD-02 Shop Drawings														

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

RR1 Repair by Replacement

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		33 82 00	Telecommunications Outside Plant	1.6.1.1	G												
			Telecommunications Entrance Facility Drawings	1.6.1.2	G												
			SD-03 Product Data														
			Wire and Cable	2.7	G												
			Cable Splices, and Connectors	2.4	G												
			Closures	2.3	G												
			Building Protector Assemblies	2.2.1	G												
			Protector Modules	2.2.2	G												
			SD-06 Test Reports														
			Pre-installation Tests	3.4.1	G												
			Acceptance Tests	3.4.2	G												
			Outside Plant Test Plan	1.6.3	G												
			SD-07 Certificates														
			Telecommunications Contractor	1.6.2.1	G												
			Key Personnel	1.6.2.2	G												
			Manufacturer's Qualifications	1.6.2.3	G												
			SD-08 Manufacturer's Instructions														
			Building Protector Assembly Installation	2.2.1	G												
			Cable Tensions	3.1.7.1	G												
			Fiber Optic Splices	3.1.8.2	G												
			SD-09 Manufacturer's Field Reports														
			Factory Reel Test Data	2.13.1	G												

[illegible]

This page is intentionally left blank.

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

GREEN BUILDING INITIATIVE (GBI)

GBI DOD GP Compliance (2017) GBI Department of Defense Guiding Principles Compliance Program for New Construction

INTERNATIONAL CODE COUNCIL (ICC)

ICC IgCC (2021) 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; with Change 1, 2020; Change 2, 2022) 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)

10 CFR 433.300 Subpart C - Green Building Certification for Federal Buildings

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), and Third Party Certification (TPC) requirements, 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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section [01 33 00](#) SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preliminary High Performance and Sustainable Building Checklist; G

Sustainability Action Plan; G

Preliminary Sustainability eNotebook; G

SD-06 Test Reports

Third Party Certification Design Compliance Report; G

SD-11 Closeout Submittals

Final High Performance and Sustainable Building Checklist; G

Final Sustainability eNotebook; G

Amended Final Sustainability eNotebook; G

Amended Final High Performance and Sustainable Building Checklist;
G

Third Party Certification Certificate, Assessment, or Validation
and Compliance Report; G

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 REQUIREMENTS. 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, including "S" submittals

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 "S" Submittals for Sustainability Documentation

"S" submittals are the sustainability documentation requirements cited in the various sections of this contract. Submit the GPV and TPC sustainability documentation required in this section as "S" submittals in all affected UFGS Sections.

- a. Highlight GPV and TPC compliance data in "S" submittal.
- b. Add "S" submittals to the Sustainability eNotebook only after submittal approval, and bookmark them as required in paragraph SUSTAINABILITY ENOTEBOOK below.
- c. Ensure all approved "S" 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 and TPC 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. "S" submittals
- f. Certifications, assessments, or validations and compliance report
- g. TPC documentation required in paragraph THIRD PARTY CERTIFICATION (TPC).

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](#) and TPC checklist at the first post award meeting in accordance with Section 01 30 00 ADMINISTRATIVE REQUIREMENTS.

d. [Third Party Certification Design Compliance Report](#)

Obtain Third Party Certification Design Compliance Report after final design submittal is approved. Submittal must indicate 100 percent compliance with applicable design requirements. File approved submittal in the Sustainability eNotebook.

e. Construction Quality Control Meetings.

Provide up-to-date GP and TPC documentation in the Sustainability eNotebook and TPC Online tool for each meeting.

f. [Final Sustainability eNotebook](#)

Submit updated Sustainability eNotebook with updated [Final High Performance and Sustainable Building Checklist](#) with TPC 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](#) and amended TPC 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, TPC 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 20 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 20 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. Coordinate with moisture control requirements in Section 01 45 00.00 20 Quality Control.

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, refer to submittal requirement for recycled/recovered material content in Section 01 78 00 CLOSEOUT SUBMITTALS.

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 Section 01 78 00 CLOSEOUT SUBMITTALS, paragraphs CERTIFICATION OF EPA DESIGNATED ITEMS and CERTIFICATION OF USDA DESIGNATED ITEMS.

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

Provide the additional sustainability requirements cited in this paragraph.

1.6.14.1 Third Party Certification (TPC) Documentation

Third Party Certification certificate, assessment, or validation, and compliance report requirements are in addition to all requirements under header above GUIDING PRINCIPLES VALIDATION (GPV).

1.6.14.1.1 TPC Registration

This project has been designed for, and must be constructed to achieve GBI DOD GP Compliance . Project is already registered with the TPC Organization. Provide construction related sustainability documentation, in the format required by the TPC Organization, to the Contracting Officer for approval, and for final approval by the TPC organization. Third Party Certification is met when Government receives TPC organization certificate, assessment, or validation and compliance report and plaque. Execute the following:

- a. Refer to TPC Checklist at the end of this specification section.
(Multiple checklists indicate multiple buildings that require TPC.)

- b. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved TPC Requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.
- c. Complete all work required to incorporate the applicable TPC Requirements.
- d. Maintain the construction related information in the Sustainability eNotebook pertaining to additions and changes to the approved sustainability requirements. Maintain the Sustainability eNotebook in electronic format. For more explanation, refer to paragraph SUSTAINABILITY eNOTEBOOK. Provide the following components in the Sustainability eNotebook, in addition to the GPV components above:
 - (1) TPC Checklist
 - (2) Provide construction documentation required to achieve third party certification
- e. Provide the following information in the Sustainability Action Plan. Provide this TPC information in addition to the GPV Action Plan items above:
 - (1) Planned method to achieve each TPC requirement.
 - (2) For each TPC requirement that is attempted but not achieved, provide narrative explaining how mission or activity precludes achieving specific sustainability requirement or goal. Provide analysis of particular requirement and level to which project is able to comply.
 - (3) Provide name and contact information for: Sustainability Point of Contact (POC) and other names of sustainability professionals responsible for ensuring TPC sustainability goals are accomplished and documentation is assembled. Sustainability POCs are also responsible for ensuring GPV required in paragraph GUIDING PRINCIPLES VALIDATION (GPV) above.
- f. Bear all costs associated with construction changes that affect sustainability design requirements, constructing, demonstrating, and documenting that project complies with approved TPC requirements, including but not limited to:
 - (1) TPC coordination with Government's AE and other consultants, TPC website requirements, and management for construction related documentation.
 - (2) Construction work required to incorporate TPC requirements.
 - (3) Submittals required to demonstrate compliance with Government approved TPC checklists.
 - (4) Documentation illustrating compliance with TPC requirements and additional documentation required by the TPC.
- g. Provide all calculations, product data, and certifications, assessments, or validations required in this contract to demonstrate

compliance with the TPC Requirements of this section.

1.6.14.2 Third Party Certification (TPC) Documentation

Third Party Certification certificate, assessment, or validation, and compliance report requirements are in addition to all requirements under header above GUIDING PRINCIPLES VALIDATION (GPV).

1.6.14.2.1 TPC Registration Required

Pay all fees associated with registration and achievement of Third Party Certification (TPC), by meeting all TPC and project requirements to achieve **GBI DOD GP Compliance**, or Government-approved equivalent TPC sustainability certification, assessment, or validation. An equivalent TPC organization must demonstrate equivalency for Government consideration and meet the requirements of **10 CFR 433.300**, prior to use on the project. Third Party Certification is met when Government receives TPC organization certificate, assessment, or validation and compliance report and plaque.

Register project with TPC organization using the following format and content:

- a. Project Title First Line: Building Owner (US Army, US Air Force, US Navy or US Marine Corps), Building Name (if known)
- b. Project Title Second Line: MILCON P#, DD1391 Project Name
- c. Project Address: UIC (Installation code), Category code, RPUID (Real Property Unique Identifier) Number
- d. Project Owner Organization: US Army, US Air Force, US Navy or US Marine Corps
- e. Primary Contact, Project Owner: Component Project Manager
- f. Building Owner Organization: US Army, US Air Force, US Navy or US Marine Corps
- g. Building Owner Organization Project Number
- h. Additional Contact, Building Owner: Department of Public Works, Public Works Officer, Base Civil Engineer, or Designee

1.6.14.2.2 TPC Already Registered

Project is already registered with TPC organization to achieve **GBI DOD GP Compliance**. When applicable, request TPC online access turnover from Government. Manage and provide all documentation for requirements of TPC and obtain Final Certification or validation. Third Party Certification is met when Government receives TPC organization certificate, assessment, or validation and compliance report and plaque.

1.6.14.2.3 TPC Management and Certification

Execute the following TPC Certification, assessment, or validation requirements:

- a. Refer to TPC Checklist at the end of this specification section.
(Multiple checklists indicate multiple buildings that require TPC.)

- b. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved TPC Requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.
- c. Complete all work required to incorporate the applicable TPC Requirements.
- d. Maintain the construction related information in the Sustainability eNotebook pertaining to additions and changes to the approved sustainability requirements. When construction changes are made that affect design sustainability requirements, provide all required updates to affected design requirements and update in the Sustainability eNotebook. Maintain the Sustainability eNotebook in electronic format. For more explanation, refer to paragraph SUSTAINABILITY eNOTEBOOK. Provide the following components in the Sustainability eNotebook, in addition to the GPV components above:

- (1) TPC Checklist

- (2) Completed TPC forms. Transmit by the method required by the TPC organization.

- (3) Copy of all correspondence with the TPC organization including proof of TPC registration

- (4) Documentation illustrating compliance with TPC requirements and additional documentation as requested by the TPC

- (5) TPC Award Certificate, assessment, or validation and compliance report.

- e. Provide the following information in the Sustainability Action Plan. Provide this TPC information in addition to the Sustainability Action Plan items above:

- (1) Planned method to achieve each TPC requirement.

- (2) For each TPC requirement that is attempted but not achieved, provide narrative explaining how mission or activity precludes achieving specific sustainability requirement or goal. Provide analysis of particular requirement and level to which project is able to comply.

- (3) Provide name and contact information for: Sustainability point of contact (POC) and other names of sustainability professionals responsible for ensuring TPC sustainability goals are accomplished and documentation is assembled. Sustainability POCs are also responsible for ensuring GPV required in paragraph GUIDING PRINCIPLES VALIDATION (GPV) above.

- f. Bear all costs associated with construction changes that affect sustainability design requirements, constructing, demonstrating, and documenting that project complies with approved TPC requirements, including but not limited to:

- (1) Final TPC review, certification, assessment, or validation and plaque fees.

- (2) Online (or offline with secure facilities) TPC management and documentation.
- (3) Obtaining TPC certification or validation based on Government-approved sustainability goals.
- (4) Construction work required to incorporate TPC requirements.
- (5) Submittals required to demonstrate compliance with Government approved TPC checklists.
- g. Provide all calculations, product data, and certifications, assessments, or validations required in this specification to demonstrate compliance with the TPC Requirements.
- h. Provide all TPC management and documentation. Transmit TPC requirements by the method required by TPC organization.
- i. Provide all required responses to third party organization.
- j. Facilitate and participate in required TPC site visit. Coordinate with the Contract Officer to determine participating team members. Include Commissioning provider on applicable projects.
- k. Provide TPC Plaque and Certificate, assessment, or validation. Provide TPC compliance report that includes level achieved and reasons for non-compliance or not applicable elements. Use format below to create the Plaque, Certificate, assessment or validation, compliance report, and Letter of Congratulations (when provided). Forward to parties designated by Contracting Officer:

(1) Plaque:

Name: Final Building Name. If unknown, provide Form DD1391 Project Name.

(2) Certificate, Assessment or Validation:

Project Title, first line: P-(X); Form DD1391 Project Name).

Project Title, second line: UIC (Installation code)

(3) Letter Congratulations (when provided):

Address letter to Facility's Installation Commander Name. Address the letter to an individual person.

(4) Compliance Report:

Title page must cite Project title: P-(X); (1391 Project Name); Final Building Name if known; UIC (installation code); Owner Service; User organization if known; date of compliance.

Include TPC scoresheet if applicable.

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 TPC accredited sustainability professional responsible for GP and TPC documentation participates in these meetings to coordinate documentation completion. Review GP and TPC sustainability requirements, HPSB Checklist and TPC documentation, Sustainability Action Plan, and completeness status of Sustainability eNotebook, and TPC status at the following meetings:

- a. Pre-Construction Conference
- b. Construction Quality Control Meetings
- f. TPC On-site Visit

Execute, coordinate, and facilitate on-site visit by third party representative no later than 60 days before final turnover, or as required by TPC organization, whichever is greater.

- 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 final TPC certification, assessment or validation, and actions that will achieve requirements. Conduct corrective actions prior to turnover, to ensure all requirements are achieved.

3.2 THIRD PARTY CERTIFICATION CERTIFICATE, ASSESSMENT, OR VALIDATION AND COMPLIANCE REPORT

Finalize the process requirements and obtain the TPC Plaque and Certificate, assessment, or validation, and compliance report, indicating completion of the project's sustainability goals. Include TPC compliance report with final TPC scoresheet as applicable.

Provide one original framed copy of the certificate, assessment, or validation, mounted in 1 inch deep metal frames, with double matt, and wire hangers, in location approved by Contracting Officer. Deliver two original certificate, assessment, or validation, and compliance report to Contractor Officer, unless otherwise instructed. Provide and hang Plaque in a prominent interior location approved by the Contracting Officer.

3.3 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) 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

NAVFAC HIGH PERFORMANCE AND SUSTAINABLE BUILDING CHECKLIST -- GOALS

PROJECT INFORMATION

Work Order No.: _____ FY _____ MILCON P No. / Customer Reference No.: _____
Project Title: _____
Location UIC/Name: _____
NAVFAC Project Manager: _____ Project Design Level: _____
Facility Area: _____ U/M: _____ Category Code: _____ Facility #: _____
AE Contract # & T.O. _____ AE Firm Sustainability Coordinator: _____
AE Firm Name: _____
Project Phase: _____ Design Start / PDA _____ Solicitation Documents Complete _____
Construction Contract _____ Award Date (P): _____ BOD (P): _____

SUSTAINABILITY DATA - GUIDING PRINCIPLES for SUSTAINABLE DEVELOPMENT

Use this form to collect Design Goals information to be recorded on the Sustainable and Energy Tab in eProjects

NOTE: 1. Mark "N/A" only when at least one of the listed justifications is applicable, and mark those justifications. Otherwise, mark "Yes."
2. If project is for more than one building for which tracking is required, complete a separate form for each building.

PRELIMINARY PROJECT INFORMATION

1 How many buildings are included in this project? _____

2 New building or stand-alone addition $\geq 10,000$ GSF

-OR-

Existing building renovation (including additions) $\geq 10,000$ GSF, and with a cost $> \$3M$ Yes _____ No _____
and 50% Estimated Replacement Cost (ERC)?

3 Identify the building to be tracked in this tab: _____

DESIGN DEVELOPMENT - DOCUMENTATION OF COMPLIANCE WITH GUIDING PRINCIPLES

I. Employ Integrated Design Principles

1 Integrated Design

Goals In Compliance _____ Yes _____ N/A _____
N/A due to _____
_____ Mission preclusion _____ Building/site issue
_____ Not LCCE _____ Renovation only: not part of scope
_____ Installation/region issue

2 Commissioning

Goals In Compliance _____ Yes _____ N/A _____
N/A due to _____
_____ Mission preclusion _____ Building/site issue
_____ Not LCCE _____ Renovation only: not part of scope
_____ Installation/region issue

(i) Systems commissioned

II. Optimize Energy Performance

3. Energy Efficiency

Goals In Compliance _____ Yes _____ N/A _____
N/A due to _____
_____ Mission preclusion _____ Building/site issue
_____ Not LCCE _____ Renovation only: not part of scope
_____ Installation/region issue

(i) Energy Savings Below Baseline % _____

(ii) Energy Standard

_____ ASHRAE 90.1-2013 (06NOV16+)
_____ ASHRAE 90.1-2016

_____ IECC
_____ OTHER:

C. Energy Efficient Products

<u>Goals</u>	In Compliance	_____ Yes	_____ N/A
		N/A due to	
		_____ Mission preclusion	_____ Building/site issue
		_____ Not LCCE	_____ Renovation only: not part of scope
		_____ Installation/region issue	

4. Renewable Energy

<u>Goals</u>	In Compliance	_____ Yes	_____ N/A
		N/A due to	
		_____ Mission preclusion	_____ Building/site issue
		_____ Not LCCE	_____ Renovation only: not part of scope
		_____ Installation/region issue	

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

<u>Goals</u>	In Compliance	_____ Yes	_____ N/A
		N/A due to	
		_____ Mission preclusion	_____ Building/site issue
		_____ Not LCCE	_____ Renovation only: not part of scope
		_____ Installation/region issue	

(i) Annual % of total load _____

(ii) System size (kBtu/Year) _____

5. Meter (Energy)

<u>Goals</u>	In Compliance	_____ Yes	_____ N/A
		N/A due to	
		_____ Mission preclusion	_____ Building/site issue
		_____ Not LCCE	_____ Renovation only: not part of scope
		_____ Installation/region issue	

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

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

(i) Total Design Indoor Water Use Intensity (WUI): Gallons/Sq Ft/Year

B. Indoor Water Meter

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

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

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

B. Water-efficient landscape

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

9. Alternative Water Use (indoor or outdoor water)

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

Methods Proposed:

☐ 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

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

B. Thermal Comfort

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

12. Daylighting and Lighting Controls

A. Daylight

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

B. Automatic dimming controls

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

13. Indoor Air Quality

A. Moisture Control

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

B. Low-Emitting Materials

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

C. Indoor Air Quality during Construction

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

14. Occupant Health and Wellness

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

V. Reduce the Environmental Impact of Materials

15. Material Content and Performance

A. Resource Conservation and Recovery Act (RCRA) Section 6002 (recycled content)

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

B. Farm Security and Rural Investment Act (FSRIA) section 9002 (Biobased content)

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

16. Waste Management

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

17. Waste Diversion - 60% target

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

(i) Percent diverted

VI. Assess and Consider Climate Change Risks

18. Address Climate Change Risk

Goals In Compliance ☐ Yes ☐ N/A
N/A due to
☐ Mission preclusion ☐ Building/site issue
☐ Not LCCE ☐ Renovation only: not part of scope
☐ Installation/region issue

THIRD PARTY CERTIFICATION INFORMATION

Is this building pursuing Third Party Certification? ☐ Yes ☐ No

N/A due to ☐ Installation/region issue ☐ Mission preclusion ☐ Renovation only: not part of scope

Sustainability Third Party Certification Rating

Third Party Certification Rating System and Level

<input type="checkbox"/> USGBC LEED Certified	<input type="checkbox"/> GBI Green Globes 1 Globe
<input type="checkbox"/> USGBC LEED Silver	<input type="checkbox"/> GBI Green Globes 2 Globe
<input type="checkbox"/> USGBC LEED Gold	<input type="checkbox"/> GBI Green Globes 3 Globe
<input type="checkbox"/> USGBC LEED Platinum	<input type="checkbox"/> GBI Green Globes 4 Globe
<input type="checkbox"/> USGBC "Guiding Principles Assessment"	<input type="checkbox"/> GBI "Guiding Principles Compliance"
<input type="checkbox"/> OTHER	

i. Third Party Certification Rating system - Other

This page is intentionally left blank.

SECTION 01 35 29

SAFETY AND OCCUPATIONAL HEALTH REQUIREMENTS

07/21

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.

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z359.1 (2020) The Fall Protection Code

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B30.22 (2016) Articulating Boom Cranes

ASME B30.3 (2020) Tower Cranes

ASME B30.5 (2018) Mobile and Locomotive Cranes

ASME B30.8 (2015) Floating Cranes and Floating
Derricks

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 10 (2018; ERTA 1-2 2018) Standard for
Portable Fire Extinguishers

NFPA 241 (2019) Standard for Safeguarding
Construction, Alteration, and Demolition
Operations

NFPA 51B (2019; TIA 20-1) Standard for Fire
Prevention During Welding, Cutting, and
Other Hot Work

NFPA 70 (2023) National Electrical Code

NFPA 70E (2021) Standard for Electrical Safety in
the Workplace

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2014) Safety -- Safety and Health
Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910 Occupational Safety and Health Standards

29 CFR 1910.146 Permit-required Confined Spaces

29 CFR 1910.94	Ventilation
29 CFR 1915	Confined and Enclosed Spaces and Other Dangerous Atmospheres in Shipyard Employment
29 CFR 1919	Gear Certification
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.500	Fall Protection

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Accident Prevention Plan (APP)
Activity Hazard Analysis (AHA)
Crane Critical Lift Plan
Crane Work Plan
Proof of qualifications for Crane Operators

SD-06 Test Reports

Reports

Submit reports as their incidence occurs, in accordance with the
requirements of the paragraph entitled, "Reports."

Accident Reports
Monthly Exposure Reports
Regulatory Citations and Violations
Crane Reports

SD-07 Certificates

Confined Space Entry Permit
Certificate of Compliance (Crane)
Third Party Certification of Barge-Mounted Mobile Cranes
Submit one copy of each permit/certificate attached to each Daily
Report.

1.3 DEFINITIONS

- a. Associate Safety Professional (ASP). An individual who is currently certified by the Board of Certified Safety Professionals.
- b. Certified Construction Health & Safety Technician (CHST). An individual who is currently certified as a CHST by the Board of Certified Safety Professionals.
- c. Certified Industrial Hygienist (CIH). An individual who is currently certified as a CIH by the American Board of Industrial Hygiene.
- d. Certified Safety Professional (CSP). An individual who is currently certified as a CSP by the Board of Certified Safety Professionals.
- e. Certified Safety Trained Supervisor (STS). An individual who is currently certified as an STS by the Board of Certified Safety Professionals.
- f. Competent Person for Fall Protection. A person who is capable of identifying hazardous or dangerous conditions in the personal fall arrest system or any component thereof, as well as their application and use with related equipment, and has the authority to take prompt corrective measures to eliminate the hazards of falling.
- g. High Visibility Accident. Any mishap which may generate publicity and/or high visibility.
- h. Low-slope roof. A roof having a slope less than or equal to 4 in 12 (vertical to horizontal).
- i. Medical Treatment. 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 though provided by a physician or registered personnel.
- j. Multi-Employer Work Site (MEWS). A multi-employer work site, as defined by OSHA, is one in which many employers occupy the same site. The Government considers the Prime Contractor to be the "controlling authority" for all work site safety and health of the subcontractors.
- k. Operating Envelope. The area surrounding any crane. Inside this "envelope" is the crane, the operator, riggers, rigging gear between the hook and the load, the load and the crane's supporting structure (ground, rail, etc.).
- l. Qualified Person for Fall Protection. A person with a recognized degree or professional certification, extensive knowledge, training and experience in the field of fall protection who is capable of performing design, analysis, and evaluation of fall protection systems and equipment.
- m. Recordable Injuries or Illnesses. Any work-related injury or illness that results in:
 - (1) Death, regardless of the time between the injury and death, or the length of the illness;

- (2) Days away from work;
- (3) Restricted work;
- (4) Transfer to another job;
- (5) Medical treatment beyond first aid;
- (6) Loss of consciousness; or
- (7) A significant injury or illness diagnosed by a physician or other licensed health care professional, even if it did not result in (1) through (6) above.

n. Site Safety and Health Officer (SSHO). The superintendent or other qualified or competent person who is responsible for the on-site safety and health required for the project.

o. Steep roof. A roof having a slope greater than 4 in 12 (vertical to horizontal).

p. "USACE" property and equipment specified in USACE EM 385-1-1 should be interpreted as Government property and equipment.

q. Weight Handling Equipment (WHE) Accident. A WHE accident occurs when any one or more of the six 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; and collision, including unplanned contact between the load, crane, and/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, roll over, etc.).

1.4 CONTRACTOR SAFETY SELF-EVALUATION CHECKLIST

Contracting Officer will provide a "Contractor Safety Self-Evaluation checklist" to the Contractor at the pre-construction conference. The checklist will be completed monthly by the Contractor and submitted with each request for payment voucher. An acceptable score of 90 or greater is required. Failure to submit the completed safety self-evaluation checklist or achieve a score of at least 90, will result in a 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, work performed shall comply with USACE EM 385-1-1, and the following 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 shall apply.

1.6 DRUG PREVENTION PROGRAM

Conduct a proactive drug and alcohol use prevention program for all workers, prime and subcontractor, on the site. Ensure that no employee uses illegal drugs or consumes alcohol during work hours. Ensure there are no employees under the influence of drugs or alcohol during work hours. After accidents, collect blood, urine, or saliva specimens and test the injured and involved employees for the influence of drugs and alcohol. A copy of the test shall be made available to the Contracting Officer upon request.

1.7 SITE QUALIFICATIONS, DUTIES AND MEETINGS

1.7.1 Personnel Qualifications

1.7.1.1 Site Safety and Health Officer (SSHO)

The SSHO must meet the requirements of **EM 385-1-1** section 1 and ensure that the requirements of **29 CFR 1926** are met for the project. Provide a Safety oversight team that includes a minimum of one (1) person at each project site to function as the Site Safety and Health Officer (SSHO). The SSHO or an equally-qualified Designated Representative/alternate shall 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's training, experience, and qualifications shall be as required by **EM 385-1-1** paragraph 01.A.17, entitled SITE SAFETY AND HEALTH OFFICER (SSHO), and all associated sub-paragraphs.

A Competent Person shall be provided for all of the hazards identified in the Contractor's Safety and Health Program in accordance with the accepted Accident Prevention Plan, and shall 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 Person(s) to the Contracting Officer's Representative for acceptance.
Office.

1.7.1.1.1 Additional Site Safety and Health Officer (SSHO) Requirements and Duties

The SSHO may not serve as the Quality Control (QC) Manager. The SSHO may not serve as the Superintendent.

1.7.1.2 Competent Person for Confined Space Entry

Provide a competent person meeting the requirements of **EM 385-1-1** who is assigned in writing by the Designated Authority to assess confined spaces and who possesses demonstrated knowledge, skill and ability to:

- a. Identify the structure, location, and designation of confined and permit-required confined spaces where work is done;
- b. Calibrate and use testing equipment including but not limited to, oxygen indicators, combustible gas indicators, carbon monoxide indicators, and carbon dioxide indicators, and to interpret accurately the test results of that equipment;
- c. Perform all required tests and inspections specified in **29 CFR 1910.146** and **29 CFR 1915** Subpart B;

- d. Assess hazardous conditions including atmospheric hazards in confined space and adjacent spaces and specify the necessary protection and precautions to be taken;
- e. Determine ventilation requirements for confined space entries and operations;
- f. Assess hazards associated with hot work in confined and adjacent space and determine fire watch requirements; and,
- g. Maintain records required.

When the work involves marine operations that handle combustible or hazardous materials, this qualified person shall be a NFPA certified marine chemist.

1.7.1.3 Competent Person for the Health Hazard Control and Respiratory Protection Program

Provide a competent person meeting the requirements of EM 385-1-1 who is:

- a. Capable by education, specialized training and/or experience of anticipating, recognizing, and evaluating employee exposure to hazardous chemical, physical and biological agents in accordance with USACE EM 385-1-1, Section 6.
- b. Capable of specifying necessary controls and protective actions to ensure worker health.

1.7.1.4 Crane Operators

Crane operators shall meet the requirements in USACE EM 385-1-1, Section 16 and Appendix G. In addition, for mobile cranes with Original Equipment Manufacturer (OEM) rated capacities of 50,000 pounds or greater, crane operators shall be designated as qualified by a source that qualifies crane operators (i.e., union, a government agency, or an organization that tests and qualifies crane operators). Proof of current qualifications shall be provided.

1.7.2 Personnel Duties

1.7.2.1 Site Safety and Health Officer (SSHO)/Superintendent

- 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. Safety inspection logs shall be attached to the Contractors' daily report.
- b. Conduct mishap investigations and complete required reports. Maintain the OSHA Form 300 and Daily Production reports for prime and sub-contractors.
- c. Maintain applicable safety reference material on the job site.
- d. Attend the pre-construction conference, pre-work meetings including preparatory inspection meeting, and periodic in-progress meetings.

- e. Implement and enforce accepted APPS and AHAs.
- f. Maintain a safety and health deficiency tracking system that monitors outstanding deficiencies until resolution. A list of unresolved safety and health deficiencies shall be posted on the safety bulletin board.
- g. Ensure sub-contractor compliance with safety and health requirements.
- h. Ensure an approved "Special Permission Energized Electrical Work Permit" prior to starting any activity on energized electrical systems.

Failure to perform the above duties will result in dismissal of the superintendent and/or SSHO, and a project work stoppage. The project work stoppage will remain in effect pending approval of a suitable replacement.

1.7.2.2 Certified Safety Professional (CSP), Certified Industrial Hygienist (CIH), Associate Safety Professional (ASP), Certified Safety Trained Supervisor (STS), and/or Certified Construction Health & Safety Technician (CHST)

- a. Perform safety and occupational health management, surveillance, inspections, and safety enforcement for the project.
- b. Perform as the safety and occupational health "competent person" as defined by USACE EM 385-1-1.
- c. Be on site whenever work or testing is being performed.
- d. Conduct and document safety inspections.
- e. Shall have no other duties other than safety and occupational health management, inspections, and enforcement on this contract.

If the CSP, CIH, ASP, STS, CHST is appointed as the SSHO all duties of that position shall also be performed.

1.7.3 Meetings

1.7.3.1 Preconstruction Conference

- a. The Contractor will be informed, in writing, of the date of the preconstruction conference. The purpose of the preconstruction conference is for the Contractor and the Contracting Officer's representatives to become acquainted and explain the functions and operating procedures of their respective organizations and to reach mutual understanding relative to the administration of the overall project's Accident Prevention Plan (APP) before the initiation of work.
- b. Contractor representatives who have a responsibility or significant role in accident prevention on the project shall attend the preconstruction conference. This includes the project superintendent, site safety and health officer, quality control supervisor, 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).
- c. The Contractor shall 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 at the conference and an agreement will be reached between the Contractor and the Contracting Officer's representative as to which phases will require an analysis. In addition, a schedule for the preparation, submittal, review, and acceptance of AHAs shall be established to preclude project delays.

d. Deficiencies in the submitted APP will be brought to the attention of the Contractor at the preconstruction conference, and the Contractor shall revise the plan to correct deficiencies and re-submit it for acceptance. Work shall not begin until there is an accepted APP.

e. The functions of a Preconstruction conference may take place at the Post-Award Kickoff meeting for Design Build Contracts.

1.7.3.2 Weekly Safety Meetings

Conduct weekly safety meetings at the project site for all employees. The Contracting Officer will be informed of the meeting in advance and be allowed attendance. Minutes showing contract title, signatures of attendees and a list of topics discussed shall be attached to the Contractors' daily report.

1.7.3.3 Work Phase Meetings

The appropriate AHA shall be reviewed and attendance documented by the Contractor at the preparatory, initial, and follow-up phases of quality control inspection. The analysis should be used during daily inspections to ensure the implementation and effectiveness of safety and health controls.

1.8 TRAINING

1.8.1 New Employee Indoctrination

New employees (prime and sub-contractor) will be informed of specific site hazards before they begin work. Documentation of this orientation shall be kept on file at the project site.

1.8.2 Periodic Training

Provide Safety and Health Training in accordance with USACE EM 385-1-1 and the accepted APP. Ensure all required training has been accomplished for all onsite employees.

1.8.3 Training on Activity Hazard Analysis (AHA)

Prior to beginning a new phase, training will be provided to all affected employees to include a review of the AHA to be implemented.

1.9 ACCIDENT PREVENTION PLAN (APP)

The Contractor shall use a qualified person to prepare the written site-specific APP. Prepare the APP in accordance with the format and requirements of USACE EM 385-1-1 and as supplemented herein. Cover all paragraph and subparagraph elements in USACE EM 385-1-1, Appendix A,

"Minimum Basic Outline for Preparation of Accident Prevention Plan". Where a paragraph or subparagraph element is not applicable to the work to be performed indicate "Not Applicable" next to the heading. Specific requirements for some of the APP elements are described below at paragraph 1.8.1. The APP shall be job-specific and shall address any unusual or unique aspects of the project or activity for which it is written. The APP shall interface with the Contractor's overall safety and health program. Any portions of the Contractor's overall safety and health program referenced in the APP shall be included in the applicable APP element and made site-specific. 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 shall be signed by the person and firm (senior person) preparing the APP, the Contractor, the on-site superintendent, the designated site safety and health officer and any designated CSP and/or CIH.

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. The Contracting Officer reviews and comments on the Contractor's submitted APP and accepts it when it meets the requirements of the contract provisions.

Once 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 will be cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified.

Once work begins, changes to the accepted APP shall be made with the knowledge and concurrence of the Contracting Officer, project superintendent, SSHO and quality control manager. Should any unforeseen hazard become evident during the performance of work, the project superintendent shall inform the Contracting Officer, both verbally and in writing, for resolution as soon as possible. In the interim, all necessary action shall be taken by the Contractor to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment.

Copies of the accepted plan will be maintained at the resident engineer's office and at the job site. The APP shall be continuously reviewed and amended, as necessary, throughout the life of the contract. Unusual or high-hazard activities not identified in the original APP shall be incorporated in the plan as they are discovered.

1.9.1 EM 385-1-1 Contents

In addition to the requirements outlines in Appendix A of USACE EM 385-1-1, the following is required:

- a. Names and qualifications (resumes including education, training, experience and certifications) of all 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 such as CSPs, CIHs, STSs, CHSTs. The duties of each position shall be specified.

b. Qualifications of competent and of qualified persons. As a minimum, competent persons shall be designated and qualifications submitted 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; personal protective equipment and clothing to include selection, use and maintenance.

c. Confined Space Entry Plan. Develop a confined space entry plan in accordance with USACE EM 385-1-1, applicable OSHA standards 29 CFR 1910, 29 CFR 1915, and 29 CFR 1926, 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.)

d. Health Hazard Control Program. The Contractor shall designate a competent and qualified person to establish and oversee a Health Hazard Control Program in accordance with USACE EM 385-1-1, Section 6. The program shall ensure that employees, on-site Government representatives, and others, are not adversely exposed to chemical, physical and biological agents and that necessary controls and protective actions are instituted to ensure health.

e. Crane Critical Lift Plan. Prepare and sign weight handling critical lift plans for lifts over 75 percent of capacity of the crane or hoist (or lifts over 50 percent of the capacity of a barge mounted mobile crane's hoists) at any radius of lift; lifts involving more than one crane or hoist; lifts of personnel; and lifts involving more than rigging or operation, sensitive equipment, or unusual safety risks. The plan shall be submitted 15 calendar days prior to on-site work and include the requirements of USACE EM 385-1-1, paragraph 16.c.18. and the following:

(1) For lifts of personnel, the plan shall demonstrate compliance with the requirements of 29 CFR 1926.500(g).

(2) For barge mounted mobile cranes, barge stability calculations identifying barge list and trim based on anticipated loading; and load charts based on calculated list and trim. The amount of list and trim shall be within the crane manufacturer's requirements.

f. Alcohol and Drug Abuse Plan

(1) Describe plan for random checks and testing with pre-employment screening in accordance with the DFAR Clause subpart 252.223-7004, "Drug Free Work Force."

(2) Description of the on-site prevention program

g. Fall Protection and Prevention (FP&P) Plan. The plan shall be site specific and address all fall hazards in the work place and during different phases of construction. It shall address how to protect and prevent workers from falling to lower levels when they are exposed to fall hazards above 1.8 m (6 feet). A qualified person for

fall protection shall prepare and sign the plan. The plan shall include fall protection and prevention systems, equipment and methods employed for every phase of work, responsibilities, assisted rescue self-rescue and evacuation procedures, training requirements, and monitoring methods. Fall Protection and Prevention Plan shall be revised every six months for lengthy projects, reflecting any changes during the course of construction due to changes in personnel, equipment, systems or work habits. The accepted Fall Protection and Prevention Plan shall be kept and maintained at the job site for the duration of the project. The Fall Protection Plan shall be included in the Accident Prevention Plan (APP)

h. Training Records and Requirements. List of mandatory training and certifications which are applicable to this project (e.g. explosive actuated tools, confined space entry, fall protection, crane operation, vehicle operator, forklift operators, personal protective equipment); list of requirements for periodic retraining/certification; outline requirements for supervisory and employee safety meetings.

i. Occupant Protection Plan. The safety and health aspects of lead-based paint removal, prepared in accordance with Section 02 83 19.00 10 Lead Based Paint Hazard Abatement, Target Housing & Child Occupied Facilities, 02 82 33.13 20 Removal/Control and Disposal of Lead Containing Paint.

j. Lead Compliance Plan. The safety and health aspects of lead work, prepared in accordance with Section 02 83 13.00 20 Lead in Construction.

k. Asbestos Hazard Abatement Plan. The safety and health aspects of asbestos work, prepared in accordance with Section 02 2 16.00, "Engineering Control of Asbestos Containing Materials"

l. Site Safety and Health Plan. The safety and health aspects prepared in accordance with this section.

m. PCB Plan. The safety and health aspects of Polychlorinated Biphenyls work, prepared in accordance with Sections 02 84 33, "Removal and Disposal of Polychlorinated Biphenyls (PCBs) and 02 61 23, "Removal and Disposal of PCB Contaminated Soils)".

n. Site Demolition Plan. The safety and health aspects prepared in accordance with Section 02 41 00.00 40, Demolition" and referenced sources. Include engineering survey as applicable.

o. Excavation Plan. The safety and health aspects prepared in accordance with Section 3100, Earthwork.

p. [Crane Work Plan](#). The contractor shall provide a crane work plan to the Contracting Officer for acceptance. The crane work plan shall include the specific model of each crane and a drawing identifying their locations (exact), the dimensions, wheel sizes, number of wheels, wheel spacing, tire pressure(s), number of axles, axle spacing, minimum wheel load to be exerted during operations and maximum outrigger load to be exerted during operations. The Contractor shall allow at least 10 working days for acceptance/non-acceptance of the crane work plan. No crane operations shall begin prior to written acceptance of the crane plan by the Government. ROICC shall be the

government approving authority.

1.10 ACTIVITY HAZARD ANALYSIS (AHA)

The Activity Hazard Analysis (AHA) format shall be in accordance with USACE EM 385-1-1. Submit the AHA for review at least 15 calendar days prior to the start of each phase. Format subsequent AHA as amendments to the APP. An AHA will be developed by the Contractor for every operation involving a type of work presenting hazards not experienced in previous project operations or where a new work crew or subcontractor is to perform work. The analysis must identify and evaluate hazards and outline the proposed methods and techniques for the safe completion of each phase of work. At a minimum, define activity being performed, sequence of work, specific safety and health hazards anticipated, control measures (to include personal protective equipment) to eliminate or reduce each hazard to acceptable levels, equipment to be used, inspection requirements, training requirements for all involved, and the competent person in charge of that phase of work. For work with fall hazards, including fall hazards associated with scaffold erection and removal, identify the appropriate fall protection methods used. For work with materials handling equipment, address safeguarding measures related to materials handling equipment. For work requiring excavations, include requirements for safeguarding excavations. An activity requiring an AHA shall not proceed until the AHA has been accepted by the Contracting Officer's representative and a meeting has been conducted by the Contractor to discuss its contents with everyone engaged in the activity, including on-site Government representatives. The Contractor shall document meeting attendance at the preparatory, initial, and follow-up phases of quality control inspection. The AHA shall be continuously reviewed and, when appropriate, modified to address changing site conditions or operations. The analysis should be used during daily inspections to ensure the implementation and effectiveness of the activity's safety and health controls.

The AHA list will be reviewed periodically (at least monthly) at the Contractor supervisory safety meeting and updated as necessary when procedures, scheduling, or hazards change.

Activity hazard analyses shall be updated as necessary to provide an effective response to changing work conditions and activities. The on-site superintendent, site safety and health officer and competent persons used to develop the AHAs, including updates, shall sign and date the AHAs before they are implemented.

The activity hazard analyses shall be developed using the project schedule as the basis for the activities performed. Any activities listed on the project schedule will require an AHA. The AHAs will be developed by the contractor, supplier or subcontractor and provided to the prime contractor for submittal to the Contracting Officer.

1.11 DISPLAY OF SAFETY INFORMATION

Within 1 calendar days after commencement of work, erect a safety bulletin board at the job site. The following information shall be displayed on the safety bulletin board in clear view of the on-site construction personnel, maintained current, and protected against the elements and unauthorized removal:

- a. Map denoting the route to the nearest emergency care facility.

- b. Emergency phone numbers.
- c. Copy of the most up-to-date APP.
- d. Current AHA(s).
- e. OSHA 300A Form.
- f. OSHA Safety and Health Protection-On-The-Job Poster.
- g. [Confined space entry permit](#).
- h. Hot work permit.
- i. A sign indicating the number of hours worked since last lost workday accident.
- j. Safety and Health Warning Posters.

1.12 SITE SAFETY REFERENCE MATERIALS

Maintain safety-related references applicable to the project, including those listed in the article "References." Maintain applicable equipment manufacturer's manuals.

1.13 EMERGENCY MEDICAL TREATMENT

Contractors will arrange for their own emergency medical treatment. Government has no responsibility to provide emergency medical treatment.

1.14 [REPORTS](#)

1.14.1 [Accident Reports](#)

a. For recordable injuries and illnesses, and property damage accidents resulting in at least \$2,000 in damages, the Prime Contractor shall conduct an accident investigation to establish the root cause(s) of the accident, complete the Navy Contractor Significant Incident Report (CSIR) form or USACE Accident Report Form 3394 and provide the report to the Contracting Officer within 1 calendar day(s) of the accident. The Contracting Officer will provide copies of any required or special forms.

b. For a weight handling equipment accident (including rigging gear accidents) the Prime Contractor shall conduct an accident investigation to establish the root cause(s) of the accident, complete the WHE Accident Report (Crane and Rigging Gear) form and provide the report to the Contracting Officer within 30 calendar days of the accident. Crane operations shall not proceed 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.

1.14.2 Accident Notification

Notify the Contracting Officer as soon as practical, but not later than four hours, after any accident meeting the definition of Recordable Injuries or Illnesses or High Visibility Accidents, property damage equal to or greater than \$2,000, or any weight handling equipment accident.

Information shall include contractor name; contract 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 (to include type of construction equipment used, PPE used, etc.). Preserve the conditions and evidence on the accident site until the Government investigation team arrives on site and Government investigation is conducted.

1.14.3 Monthly Exposure Reports

Monthly exposure reporting to the Contracting Officer is required to be attached to the monthly billing request. This report is a compilation of employee-hours worked each month for all site workers, both prime and subcontractor. The Contracting Officer will provide copies of any special forms.

1.14.4 Regulatory Citations and Violations

Contact the Contracting Officer immediately of any OSHA or other regulatory agency inspection or visit, and provide the Contracting Officer with a copy of each citation, report, and contractor response. Correct violations and citations promptly and provide written corrective actions to the Contracting Officer.

1.14.5 Crane Reports

Submit crane inspection reports required in accordance with USACE EM 385-1-1, Appendix H and as specified herein with Daily Reports of Inspections.

1.14.6 Certificate of Compliance

The Contractor shall provide a Certificate of Compliance for each crane entering an activity under this contract (see Contracting Officer for a blank certificate). Certificate shall state that the crane and rigging gear meet applicable OSHA regulations (with the Contractor citing which OSHA regulations are applicable, e.g., cranes used in construction, demolition, or maintenance shall comply with 29 CFR 1926 and USACE EM 385-1-1 section 16 and Appendix H. Certify on the Certificate of Compliance that the crane operator(s) is qualified and trained in the operation of the crane to be used. For cranes at DOD activities in foreign countries, the Contractor shall certify that the crane and rigging gear conform to the appropriate host country safety standards. The Contractor shall also certify that all of its crane operators working on the DOD activity have been trained in the proper use of all safety devices (e.g., anti-two block devices). These certifications shall be posted on the crane.

1.14.7 Third Party Certification of Barge-Mounted Mobile Cranes

Barge-mounted mobile cranes shall be certified in accordance with 29 CFR 1919 by an OSHA accredited person.

1.15 HOT WORK

Prior to performing "Hot Work" (welding, cutting, etc.) or operating other flame-producing/spark producing devices, a written permit shall be requested from the Fire Division. CONTRACTORS ARE REQUIRED TO MEET ALL

CRITERIA BEFORE A PERMIT IS ISSUED. The Contractor will provide at least two (2) twenty (20) pound 4A:20 BC rated extinguishers for normal "Hot Work". All extinguishers shall be current inspection tagged, 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 shall be trained in accordance with NFPA 51B and remain on-site for a minimum of 30 minutes after completion of the task or as specified on the hot work permit.

- a. Oil painting materials (paint, brushes, empty paint cans, etc.), and all flammable liquids shall be removed from the facility at quitting time. All painting materials and flammable liquids shall be stored outside in a suitable metal locker or box and will require re-submittal with non-hazardous materials.
- b. Accumulation of trays, paper, shavings, sawdust, boxes and other packing materials shall be removed from the facility at the close of each workday and such material disposed of in the proper containers located away from the facility.
- c. The storage of combustible supplies shall be a safe distance from structures.
- d. Area outside the facility undergoing work shall be cleaned of trash, paper, or other discarded combustibles at the close of each workday.
- e. All portable electric devices (saws, sanders, compressors, extension chord, lights, etc.) shall be disconnected at the close of each workday. When possible, the main electric switch in the facility shall be deactivated.
- f. When starting work in the facility, Contractors shall require their personnel to familiarize themselves with the location of the nearest fire alarm boxes and place in memory the emergency phone number 911. ANY FIRE, NO MATTER HOW SMALL, SHALL BE REPORTED IMMEDIATELY.
- g. Obtain services from the FIRE DIVISION for "HOT WORK" within or around flammable materials (such as fuel systems, welding/cutting on fuel pipes) or confined spaces (such as sewer wet wells, manholes, vaults, etc.) that have the potential for flammable or explosive atmospheres.

PART 2 PRODUCTS

2.1 CONFINED SPACE SIGNAGE

The Contractor shall provide permanent signs integral to or securely attached to access covers for all required confined spaces. Signs wording: "DANGER--PERMIT-REQUIRED CONFINED SPACE - DO NOT ENTER -" in bold letters a minimum of 25 mm(one inch) in height and constructed to be clearly legible with all paint removed. The signal word "DANGER" shall be red and readable from 1.52 m(5 feet).

2.2 FALL PROTECTION ANCHORAGE

Fall protection anchorage, conforming to ASSP Z359.1, installed under the supervision of a qualified person in fall protection, shall be left in

place for continued customer use and so identified by signage stating the capacity of the anchorage (strength and number of persons who may be tied-off to it at any one time).

PART 3 EXECUTION

3.1 CONSTRUCTION AND/OR OTHER WORK

The Contractor shall comply with USACE EM 385-1-1, NFPA 241, the APP, the AHA, Federal and/or State OSHA regulations, and other related submittals and activity fire and safety regulations. The most stringent standard shall prevail.

3.1.1 Hazardous Material Use

Each hazardous material must receive approval prior to being brought onto the job site or prior to any other use in connection with this contract. Allow a minimum of 10 working days for processing of the request for use of a hazardous material. Any work or storage involving hazardous chemicals or materials must be done in a manner that will not expose Government or Contractor employees to any unsafe or unhealthful conditions. Adequate protective measures must be taken to prevent Government or Contractor employees from being exposed to any hazardous condition that could result from the work or storage. The Prime Contractor shall keep a complete inventory of hazardous materials brought onto the work-site. Approval by the Contracting Officer of protective measures and storage area is required prior to the start of the work.

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 USACE 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 are prohibited. The Contracting Officer, upon written request by the Contractor, may consider exceptions to the use of any of the above excluded materials.

3.1.3 Unforeseen Hazardous Material

The design should have identified materials such as PCB, lead paint, and friable and non-friable asbestos. If additional material, not indicated, that may be hazardous to human health upon disturbance during construction operations is encountered, stop that portion of work and notify the Contracting Officer immediately. Within 14 calendar days the Government will 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 PRE-OUTAGE COORDINATION MEETING

Contractors are required to apply for utility outages at least 15 days in advance. As a minimum, the request should include the location of the

outage, utilities being affected, duration of outage and any necessary sketches. Special requirements for electrical outage requests are contained elsewhere in this specification section. Once approved, and prior to beginning work on the utility system requiring shut down, the Contractor shall attend a pre-outage coordination meeting with the Contracting Officer to review the scope of work and the lock-out/tag-out procedures for worker protection. No work will be performed on energized electrical circuits unless proof is provided that no other means exist.

3.3 FALL HAZARD PROTECTION AND PREVENTION

The Contractor shall establish a fall protection and prevention program, for the protection of all employees exposed to fall hazards. The program shall include company policy, identify responsibilities, education and training requirements, fall hazard identification, prevention and control measures, inspection, storage, care and maintenance of fall protection equipment and rescue and escape procedures.

3.3.1 Training

The Contractor shall institute a fall protection training program. As part of the Fall Hazard Protection and Prevention Program, the Contractor shall provide training for each employee who might be exposed to fall hazards. A competent person for fall protection shall provide the training. Training requirements shall be in accordance with USACE **EM 385-1-1, section 21.**

3.3.2 Fall Protection Equipment

The Contractor shall enforce use of the fall protection equipment designated for each specific work activity in the Fall Protection and Prevention Plan and/or AHA at all times when an employee is on a surface 1.8 m(6 feet) or more above lower levels. Fall protection systems such as guardrails, personnel fall arrest system, safety nets, etc., are required when working within 1.8m (6 feet) of any leading edge. In addition to the required fall protection systems, safety skiff, personal floatation devices, life rings etc., are required when working above or next to water in accordance with USACE **EM 385-1-1**, paragraphs 05.I. and 05.J. Personal fall arrest systems are required when working from an articulating or extendible boom, swing stages, or suspended platform. In addition, personal fall arrest systems may be required when operating other equipment such as scissor lifts if the work platform is capable of being positioned outside the wheelbase. The need for tying-off in such equipment is to prevent ejection of the employee from the equipment during raising, lowering, or travel. Fall protection must comply with **29 CFR 1926.500**, Subpart M and USACE **EM 385-1-1.**

3.3.2.1 Personal Fall Arrest Equipment

Personal fall arrest equipment, systems, subsystems, and components shall meet **ASSP Z359.1**. Only a full-body harness with a shock-absorbing lanyard or self-retracting lanyard is an acceptable personal fall arrest device. Body belts may only be used as a positioning device system (for uses such as steel reinforcing assembly and in addition to an approved fall arrest system). Harnesses shall 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. Only locking snap hooks and carabiners shall be used. Webbing, straps, and ropes shall be made of synthetic fiber. The maximum free fall distance when using fall arrest

equipment shall not exceed 1.8 m (6 feet). The total fall distance and any swinging of the worker (pendulum-like motion) that can occur during a fall shall always be taken into consideration when attaching a person to a fall arrest system.

3.3.3 Fall Protection for Roofing Work

Fall protection controls shall be implemented based on the type of roof being constructed and work being performed. The roof area to be accessed shall be evaluated for its structural integrity including weight-bearing capabilities for the projected loading.

a. Low Sloped Roofs:

(1) For work within 1.8 m (6 feet) of an edge, on low-slope roofs, personnel shall be protected from falling by use of personal fall arrest systems, guardrails, or safety nets. A safety monitoring system is not adequate fall protection and is not authorized.

(2) For work greater than 1.8 m (6 feet) from an edge, warning lines shall be erected and installed in accordance with 29 CFR 1926.500 and USACE EM 385-1-1.

b. Steep Roofs: Work on steep roofs requires a personal fall arrest system, guardrails with toe-boards, or safety nets. This requirement also includes residential or housing type construction.

3.3.4 Safety Nets

If safety nets are used as the selected fall protection system on the project, they shall be provided at unguarded workplaces, leading edge work or when working over water, machinery, dangerous operations and or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors, fall arrest systems or restraint/positioning systems are impractical. Safety nets shall be tested immediately after installation with a drop test of 181.4 kg (400 pounds) dropped from the same elevation a person might fall, and every six months thereafter.

3.3.5 Existing Anchorage

Existing anchorages, to be used for attachment of personal fall arrest equipment, shall be certified (or re-certified) by a qualified person for fall protection in accordance with ASSP Z359.1. Existing horizontal lifeline anchorages shall be certified (or re-certified) by a registered professional engineer with experience in designing horizontal lifeline systems.

3.3.6 Horizontal Lifelines

Horizontal lifelines shall be **designed by a qualified person**, installed, certified and used under the supervision of a **competent person** for fall protection as part of a complete fall arrest system which maintains a safety factor of 2 (29 CFR 1926.500).

3.3.7 Guardrail Systems

Guardrails shall consist of top and mid-rails, post and toe boards. The top edge height of standard railing must be 42 inches plus or minus 3

inches above the walking/working level. When mid-rails are used, they must be installed at a height midway between the top edge of the guardrail system and the walking/working level. Posts shall be placed no more than 8 feet apart (29 CFR 1926.500 and USACE EM 385-1-1).

3.3.8 Rescue and Evacuation Procedures

When personal fall arrest systems are used, the contractor must ensure that the mishap victim can self-rescue or can be rescued promptly should a fall occur. A Rescue and Evacuation Plan shall be prepared by the contractor and 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. The Rescue and Evaluation Plan shall be included in 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).

3.4 PERSONAL PROTECTIVE EQUIPMENT

All personnel who enter a construction site area shall wear Personal Protective Equipment (PPE) at all times as outlined in the EM 385 1-1. In addition to the requirements of the EM 385 1-1, Safety Glasses (ANSI Z87.1) will be worn at all times on construction sites. Hearing protection is required in noise hazard areas or when performing noise hazard tasks. Mandatory PPE on all construction sites includes:

- a. Hard Hats
- b. Safety Glasses
- c. Safety-Toed Shoes or Boots

3.5 SCAFFOLDING

Employees shall be provided 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. Access to scaffold platforms greater than 6 m (20 feet) in height shall be accessed by use of a scaffold stair system. Vertical ladders commonly provided by scaffold system manufacturers shall not be used for accessing scaffold platforms greater than 6 m (20 feet) in height. The use of an adequate gate is required. Contractor shall ensure that employees are qualified to perform scaffold erection and dismantling. Do not use scaffold without the capability of supporting at least four times the maximum intended load or without appropriate fall protection as delineated in the accepted fall protection and prevention plan. Stationary scaffolds must be attached to structural building components to safeguard against tipping forward or backward. Special care shall be given to ensure scaffold systems are not overloaded. Side brackets used to extend scaffold platforms on self-supported scaffold systems for the storage of material is prohibited. The first tie-in shall be at the height equal to 4 times the width of the smallest dimension of the scaffold base. Work platforms shall be placed on mud sills. Scaffold or work platform erectors shall have fall protection during the erection and dismantling of scaffolding or work platforms that are more than six feet. Delineate fall protection requirements when working above six feet or above dangerous operations in the Fall Protection and Prevention (FP&P) Plan and Activity Hazard Analysis (AHA) for the phase of work.

3.5.1 Stilts

The use of stilts for gaining additional height in construction, renovation, repair or maintenance work is prohibited.

3.6 EQUIPMENT

3.6.1 Material Handling Equipment

a. Material handling equipment such as forklifts shall not be modified with work platform attachments for supporting employees unless specifically delineated in the manufacturer's printed operating instructions.

b. The use of hooks on equipment for lifting of material must be in accordance with manufacturer's printed instructions.

c. Operators of forklifts or power industrial trucks shall be licensed in accordance with OSHA.

3.6.2 Weight Handling Equipment

a. Cranes must be equipped with:

(1) Load indicating devices (LIDs) and a boom angle or radius indicator,

(2) or load moment indicating devices (LMIs).

(3) Anti-two block prevention devices.

(4) Boom hoist hydraulic relief valve, disconnect, or shutoff (stops hoist when boom reaches a predetermined high angle).

(5) Boom length indicator (for telescoping booms).

(6) Device to prevent uncontrolled lowering of a telescoping hydraulic boom.

(7) Device to prevent uncontrolled retraction of a telescoping hydraulic boom.

b. The Contractor shall notify the Contracting Officer 15 days in advance of any cranes entering the activity so that necessary quality assurance spot checks can be coordinated. Contractor's operator shall remain with the crane during the spot check.

c. The Contractor shall comply with the crane manufacturer's specifications and limitations for erection and operation of cranes and hoists used in support of the work. Erection shall be performed under the supervision of a designated person (as defined in ASME B30.5). All testing shall be performed in accordance with the manufacturer's recommended procedures.

d. The Contractor shall comply with ASME B30.5 for mobile and locomotive cranes, ASME B30.22 for articulating boom cranes, ASME B30.3 for construction tower cranes, and ASME B30.8 for floating cranes and floating derricks.

e. The presence of Government personnel does not relieve the Contractor of an obligation to comply with all applicable safety regulations. The Government will investigate all complaints of unsafe or unhealthful working conditions received in writing from contractor employees, federal civilian employees, or military personnel.

f. Each load shall be rigged/attached independently to the hook/master-link in such a fashion that the load cannot slide or otherwise become detached. Christmas-tree lifting (multiple rigged materials) is not allowed.

g. Under no circumstance shall a Contractor make a lift at or above 90% of the cranes rated capacity in any configuration.

h. When operating in the vicinity of overhead transmission lines, operators and riggers shall be alert to this special hazard and shall follow the requirements of USACE EM 385-1-1 section 11 and ASME B30.5 or ASME B30.22 as applicable.

i. Crane suspended personnel work platforms (baskets) shall not be used unless the Contractor proves that using any other access to the work location would provide a greater hazard to the workers or is impossible. Personnel shall not be lifted with a line hoist or friction crane.

j. A fire extinguisher having a minimum rating of 10BC and a minimum nominal capacity of 5lb of extinguishing agent shall be available at all operator stations or crane cabs. Portable fire extinguishers shall be inspected, maintained, and recharged as specified in NFPA 10, Standard for Portable Fire Extinguishers.

k. All employees shall be kept clear of loads about to be lifted and of suspended loads.

l. A weight handling equipment operator shall not leave his position at the controls while a load is suspended.

m. The Contractor shall use cribbing when performing lifts on outriggers.

n. The crane hook/block must be positioned directly over the load. Side loading of the crane is prohibited.

o. A physical barricade must be positioned to prevent personnel from entering the counterweight swing (tail swing) area of the crane.

p. A substantial and durable rating chart containing legible letters and figures shall be provided with each crane and securely mounted onto the crane cab in a location allowing easy reading by the operator while seated in the control station.

q. Certification records which include the date of inspection, signature of the person performing the inspection, and the serial number or other identifier of the crane that was inspected shall always be available for review by Contracting Officer personnel.

r. Written reports listing the load test procedures used along with any repairs or alterations performed on the crane shall be available

for review by Contracting Officer personnel.

s. The Contractor shall certify that all crane operators have been trained in proper use of all safety devices (e.g. anti-two block devices).

3.6.3 Equipment and Mechanized Equipment

a. Equipment shall be operated by designated qualified operators. Proof of qualifications shall be kept on the project site for review.

b. Manufacture specifications or owner's manual for the equipment shall be on site and reviewed for additional safety precautions or requirements that are sometimes not identified by OSHA or USACE EM 385-1-1. Such additional safety precautions or requirements shall be incorporated into the AHAs.

c. Equipment and mechanized equipment shall be inspected in accordance with manufacturer's recommendations for safe operation by a competent person prior to being placed into use.

d. Daily checks or tests shall be conducted and documented on equipment and mechanized equipment by designated competent persons.

3.7 EXCAVATIONS

The competent person for excavations performed as a result of contract work shall be on-site when excavation work is being performed, and shall inspect, and document the excavations daily prior to entry by workers. The competent person must evaluate all hazards, including atmospheric, that may be associated with the work, and shall have the resources necessary to correct hazards promptly. The competent person shall perform soil classification in accordance with 29 CFR 1926.

3.7.1 Utility Locations

All underground utilities in the work area must be positively identified by a third party, independent, private utility locating company in addition to any station locating service and coordinated with the station utility department. Any markings made during the utility investigation must be maintained throughout the contract.

3.7.2 Utility Location Verification

The Contractor must physically verify underground utility locations, including utility depth, by hand digging using wood or fiberglass handled tools when any adjacent construction work is expected to come within three feet of the underground system. Digging within 2 feet of a known utility must not be performed by means of mechanical equipment; hand digging shall be used. If construction is parallel to an existing utility the utility shall be exposed by hand digging every 100 feet if parallel within 5 feet of the excavation.

3.7.3 Utilities Within and Under Concrete, Bituminous Asphalt and Other Impervious Surfaces

Utilities located within concrete slabs or pier decks, 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 shall 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.

3.7.4 Shoring Systems

Trench and shoring systems must be identified in the accepted safety plan and AHA. Manufacture tabulated data and specifications or registered engineer tabulated data for shoring or benching systems shall be readily available on site for review. Job-made shoring or shielding shall have the registered professional engineer stamp, specifications, and tabulated data. Extreme care must be used when excavating near direct burial electric underground cables.

3.7.5 Trenching Machinery

Trenching machines with digging chain drives shall be operated only when the spotters/laborers are in plain view of the operator. Operator and spotters/laborers shall be provided training on the hazards of the digging chain drives with emphasis on the distance that needs to be maintained when the digging chain is operating. Documentation of the training shall be kept on file at the project site.

3.8 ELECTRICAL

3.8.1 Conduct of Electrical Work

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. Positive cable identification must be made prior to submitting any outage request for electrical systems. Arrangements are to be coordinated with the Contracting Officer and Station Utilities for identification. The Contracting Officer will not accept an outage request until the Contractor satisfactorily documents that the circuits have been clearly identified. 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 will be 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 shall be permitted to enter. When work requires Contractor to work near energized circuits as defined by the NFPA 70, high voltage personnel must use personal protective equipment that includes, as a minimum, electrical hard hat, safety shoes, insulating gloves with leather protective sleeves, fire retarding shirts, coveralls, face shields, and safety glasses. In addition, provide electrical arc flash protection for personnel as required by NFPA 70E. Insulating blankets, hearing protection, and switching suits may be required, depending on the specific job and as delineated in the Contractor's AHA.

3.8.2 Arc Flash Risk/Hazard Analysis

Contractor shall provide an Arc Flash Risk/Hazard Analysis in accordance with NFPA 70E for all locations where workers may be exposed to arc flash hazard (work on energized electrical equipment). The Arc Flash Risk/Hazard Analysis shall be sealed and signed by a qualified professional engineer.

3.8.3 Arc Flash Risk/Hazard Analysis Qualifications

Contractor shall engage the services of a qualified organization to provide Arc Flash Risk/Hazard Analysis of the electrical distribution system. Organization shall be independent of the supplier, manufacturer, and installer of the equipment. The organization shall be a first tier subcontractor. This work shall not be performed by a second tier subcontractor.

- a. Submit name and qualifications of organization. Organization shall have been regularly engaged in providing Arc Flash Risk/Hazard Analysis for a minimum of 5 years.
- b. Submit name and qualifications of the professional engineer performing the analysis. Include a list of three comparable jobs performed by the engineer with specific names and telephone numbers for reference.

3.8.4 Special Permission Energized Electrical Work Permit

All work on energized electrical systems, including high voltage, must have an approved "Special Permission Energized Electrical Work Permit." The results of a Arc Flash Risk/Hazard Analysis, per NFPA 70E, shall be included in the "Special Permission Energized Electrical Work Permit" request. Flame-resistant (FR) clothing and personal protective equipment (PPE) shall be rated for a minimum of 8 calories per square centimeter even if the flash hazard analysis indicates a lower value. A blank copy of the permit request is attached. An editable version may be obtained from the Contracting Officer.

3.8.5 Portable Extension Cords

Portable extension cords shall be sized in accordance with manufacturer ratings for the tool to be powered and protected from damage. All damaged extension cords shall be immediately removed from service. Portable extension cords shall meet the requirements of NFPA 70.

3.9 WORK IN CONFINED SPACES

The Contractor shall comply with the requirements in Section 06.I of USACE EM 385-1-1 and OSHA 29 CFR 1910.146. Any potential for a hazard in the confined space requires a permit system to be used.

- a. 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. (See Section 06.I.05 of USACE EM 385-1-1 for entry procedures.) All hazards pertaining to the space shall be reviewed with each employee during review of the AHA.

- b. 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.
- c. Ensure the use of rescue and retrieval devices in confined spaces greater than 1.5 m (5 feet) in depth. Conform to Sections 06.I.09, 06.I.10 and 06.I.11 of USACE EM 385-1-1.
- d. Sewer wet wells require continuous atmosphere monitoring with audible alarm for toxic gas detection.
- e. Include training information for employees who will be involved as entrants and attendants for the work. Conform to Section 06.I.06 of USACE EM 385-1-1.
- f. Daily Entry Permit. Post the permit in a conspicuous place close to the confined space entrance.

3.10 CRYSTALLINE SILICA

Grinding, abrasive blasting, and foundry operations of construction materials containing crystalline silica, shall comply with OSHA regulations, such as 29 CFR 1910.94, and USACE EM 385-1-1, Appendix C. The Contractor shall develop and implement effective exposure control and elimination procedures to include dust control systems, engineering controls, and establishment of work area boundaries, as well as medical surveillance, training, air monitoring, and personal protective equipment.

3.11 HOUSEKEEPING

3.11.1 Clean-Up

All debris in work areas shall be cleaned up daily or more frequently if necessary. Construction debris may be temporarily located in an approved location, however garbage accumulation must be removed each day.

3.11.2 Falling Object Protection

All areas must be barricaded to safeguard employees. When working overhead, barricade the area below to prevent entry by unauthorized employees. Construction warning tape and signs shall be posted so they are clearly visible from all possible access points. When employees are working overhead all tools and equipment shall be secured so that they will not fall. When using guardrail as falling object protection, all openings shall be small enough to prevent passage of potential falling objects.

3.12 VOLUNTARY PROTECTION PROGRAM (VPP)

The contractor shall comply with the requirements of CSP 03-01-003, Voluntary Protection Programs: Policies and Procedures.

3.12.1 ALL CONTRACTORS

- a. Contractor management demonstrates its commitment by establishing, documenting, and communicating to employees and contractors clear goals that are attainable and measurable, objectives that are relevant to

workplace hazards and trends of injury and illness, and policies and procedures that indicate how to accomplish the objectives and meet the goals.

b. Employees and contractors shall demonstrate an understanding of and be able to describe the fundamental principles of VPP.

c. All contractors, whether regularly involved in routine site operations or engaged in temporary projects such as construction or repair, shall follow the safety and health rules of the host.

d. Managers, supervisors, and non-supervisory employees of contract employers shall be made aware of:

(1) The hazards they may encounter while on the worksite.

(2) How to recognize hazardous conditions and the signs and symptoms of workplace-related illnesses and injuries.

(3) The implemented hazard controls, including safe work procedures.

(4) Emergency procedures.

e. Employees, including newly hired employees and contract employees when they reach the worksite, will have the VPP explained to them, including employee rights under the program and under the Act or 29 CFR Part 1960.

3.12.2 APPLICABLE CONTRACTORS

a. Applicable Contractor. A contractor whose employees worked or intend to work at least 1,000 hours for a VPP participant in any calendar quarter or within the last 12 months and are not directly supervised by the applicant/participant.

b. Injury and Illness Data Requirements:

(1) Prime contractor management shall maintain copies of their calendar year Applicable Contractor Injury and Illness Case Incidence Rates and shall maintain accurate record of their Total Work Hours, Total Number of Recordable Cases, Total Case Incidence Rate (TCIR), Number of Cases Involving Days Away from Work/Restricted Activity/Job Transfer, and Days Away/Restricted/Transfer Rate (DART) for all applicable contractors under their supervision.

(2) The host shall report all Applicable Contractors Injury and Illness Case Incidence Rate data to OSHA annually. Contractor Injury and Illness Case Incidence Rates shall be submitted to the G-F Safety Officer via the COR no later than 15 January for work completed each full or partial preceding calendar year or at contract completion, whichever is first.

c. All contractors, whether regularly involved in routine site operations or engaged in temporary projects such as construction or repair, shall follow the safety and health rules of the host.

d. Annually, the host shall submit an Annual Safety and Health Management System Self-Evaluation. A self-evaluation is not a compliance audit. It is a critical review of all the elements of the safety and health management system, including a review of participant and applicable contractors' injury and illness data and trends.

3.12.3 NESTED CONTRACTORS

Nested Contractors are supervised by host site management and are regularly intermingled with the owner's employees and under direct supervision by management.

a. Nested contractors and temporary employees who are supervised by host site management are governed by the host's safety and health management system and are, therefore, included in the host's rates.

b. All contractors, whether regularly involved in routine site operations or engaged in temporary projects such as construction or repair, shall follow the safety and health rules of the host.

c. Annually, the host shall submit an Annual Safety and Health Management System Self-Evaluation. A self-evaluation is not a compliance audit. It is a critical review of all the elements of the safety and health management system, including a review of participant and applicable contractors' injury and illness data and trends.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS
07/21

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.

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@acousticalsociety.org
Internet: <https://acousticalsociety.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 MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)
30 West University Drive
Arlington Heights, IL 60004-1893
Ph: 847-394-0150
Fax: 847-253-0088
E-mail: communications@amca.org
Internet: <http://www.amca.org>

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)
2111 Wilson Blvd, Suite 400
Arlington, VA 22201
Ph: 703-524-8800
Internet: <http://www.ahrinet.org>

ALUMINUM ASSOCIATION (AA)
1400 Crystal Drive
Suite 430

Arlington, VA 22202
Ph: 703-358-2960
E-Mail: info@aluminum.org
Internet: <https://www.aluminum.org/>

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)
1900 E Golf Rd, Suite 1250
Schaumburg, IL 60173
Ph: 847-303-5664
E-mail: customerservice@aamanet.org
Internet: <https://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@ashto.org
Internet: <https://www.transportation.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: <https://www.aatcc.org/>

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)
330 N. Wabash Ave., Suite 2000
Chicago, IL 60611
Ph: 202-367-1155
E-mail: info@americanbearings.org
Internet: <https://www.americanbearings.org/>

AMERICAN CONCRETE INSTITUTE (ACI)
38800 Country Club Drive
Farmington Hills, MI 48331-3439
Ph: 248-848-3700
Fax: 248-848-3701
Internet: <https://www.concrete.org/>

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)
1330 Kemper Meadow Drive
Cincinnati, OH 45240
Ph: 513-742-2020
Fax: 513-742-3355
Internet: <https://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@forestfoundation.org
Internet: <https://www.treefarmssystem.org>

AMERICAN GAS ASSOCIATION (AGA)
400 North Capitol Street, NW
Suite 450
Washington, D.C. 20001
Ph: 202-824-7000
Internet: <https://www.aga.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 INSTITUTE OF STEEL CONSTRUCTION (AISC)
130 East Randolph, Suite 2000
Chicago, IL 60601
Ph: 312-670-5444
Fax: 312-670-5403
Steel Solutions Center: 866-275-2472
E-mail: solutions@aisc.org
Internet: <https://www.aisc.org/>

AMERICAN IRON AND STEEL INSTITUTE (AISI)
25 Massachusetts Avenue, NW Suite 800
Washington, DC 20001
Ph: 202-452-7100
Internet: <https://www.steel.org/>

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)
7470 New Technology Way, Suite F
Frederick, MD 21703
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: <https://www.ansi.org/>

AMERICAN PETROLEUM INSTITUTE (API)
1220 L Street, NW
Washington, DC 20005-4070
Ph: 202-682-8000
Internet: <https://www.api.org/>

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)
P.O. Box 28518
1711 Arlingate Lane
Columbus, OH 43228-0518
Ph: 800-222-2768 or 614-274-6003
Fax: 614-274-6899
E-mail: tjones@asnt.org

Internet: <https://www.asnt.org/>

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)
1801 Alexander Bell Drive
Reston, VA 20191
Ph: 800-548-2723; 703-295-6300
Internet: <https://www.asce.org/>

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)
1791 Tullie Circle, NE
Atlanta, GA 30329
Ph: 404-636-8400 or 800-527-4723
Fax: 404-321-5478
E-mail: ashrae@ashrae.org
Internet: <https://www.ashrae.org/>

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
Two Park Avenue
New York, NY 10016-5990
Ph: (800) 843-2763
E-mail: CustomerCare@asme.org
Internet:

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)
520 N. Northwest Highway
Park Ridge, IL 60068
Ph: 847-699-2929
E-mail: customerservice@assp.org
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
Internet: <http://www.asse-plumbing.org>

AMERICAN WATER WORKS ASSOCIATION (AWWA)
6666 W. Quincy Avenue
Denver, CO 80235 USA
Ph: 303-794-7711 or 800-926-7337
Fax: 303-347-0804
Internet: <https://www.awwa.org/>

AMERICAN WELDING SOCIETY (AWS)
8669 NW 36 Street, #130
Miami, FL 33166-6672
Ph: 800-443-9353
Internet: <https://www.aws.org/>

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: <https://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>

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>

ASSOCIATED AIR BALANCE COUNCIL (AABC)
1220 19th St NW, Suite 410
Washington, DC 20036
Ph: 202-737-0202
Fax: 202-315-0285
E-mail: info@aabc.com
Internet: <https://www.aabc.com/>

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)
600 North 18th Street
P.O. Box 2641
Birmingham, AL 35291
Ph: 205-257-3839
Fax: 205-257-2540
Internet: <https://aeic.org/>

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9500
Fax: 610-832-9555
E-mail: service@astm.org
Internet: <https://www.astm.org/>

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)
355 Lexington Avenue, 15th Floor
New York, NY 10017
Ph: 212-297-2122
Fax: 212-370-9047
Internet: <https://www.buildershardware.com/>

CALIFORNIA AIR RESOURCES BOARD (CARB)
1001 I Street
Sacramento, CA 95814
Ph: 800-242-4450
Email: helpline@arb.ca.gov
Internet: <https://ww2.arb.ca.gov/>

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)
PO Box 997377, MS 0500
Sacramento, CA 95899-7377
Ph: 916-558-1784
Internet: <https://www.cdph.ca.gov/>

CARPET AND RUG INSTITUTE (CRI)

P.O. Box 2048
Dalton, GA 30722-2048
Ph: 706-278-3176
Fax: 706-278-8835
Internet: <https://carpet-rug.org/>

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

1600 Clifton Road
Atlanta, GA 30329-4027
Ph: 800-232-4636
TTY: 888-232-6348
Internet: <https://www.cdc.gov>

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/>

CONSUMER ELECTRONICS ASSOCIATION (CEA)

1919 South Eads St.
Arlington, VA 22202
Ph: 703-907-7600
E-mail: CTA@CTA.tech
Internet: <https://www.cta.tech/>

COPPER DEVELOPMENT ASSOCIATION (CDA)

Internet: <https://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: member@csagroup.org
Internet: <https://www.csagroup.org/>

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

310 Maxwell Road, Suite 200
Alpharetta, GA 30009
Ph: 678-393-9990
Fax: 678-393-9998
E-mail: emikoski@ecianow.org
Internet: <https://www.ecianow.org>

EUROPEAN UNION (EU)
European Commission
Rue de la Loi 200
1000 Bruxelles
Belgium
Ph: +32 2 299 96 96
Internet: https://ec.europa.eu/info/index_en

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/>

FM GLOBAL (FM)
270 Central Avenue
Johnston, RI 02919-4949
Ph: 401-275-3000
Fax: 401-275-3029
Internet: <https://www.fmglobal.com/>

FOREST STEWARDSHIP COUNCIL (FSC)
708 First Street North, Suite 235
Minneapolis, MN 55401
Ph: 612-353-4511
E-mail: info@us.fcs.org
Internet: <https://us.fsc.org/>

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH
(FCCCHR)
USC Foundation Office
Research Annex 219
Los Angeles, CA 90089-7700
Ph: 866-545-6340
Fax: 213-740-8399
E-mail: fccchr@usc.edu
Internet: <https://fccchr.usc.edu/>

GLASS ASSOCIATION OF NORTH AMERICA (GANA)
National Glass Association
1945 Old Gallows Rd., Suite 750
Vienna, VA 22182
Ph: 866-342-5642
Ph: 703-442-4890
Fax: 703-442-0630
Internet: <http://www.glasswebsite.com>

GREEN BUILDING INITIATIVE (GBI)
7805 SW 40th Ave. #80010

Portland, Oregon 97219
Ph: 503-274-0448
Email: info@thegbi.org
Internet: <https://www.thegbi.org/>

GREEN SEAL (GS)
1001 Connecticut Avenue, NW
Suite 827
Washington, DC 20036-5525
Ph: 202-872-6400
Fax: 202-872-4324
E-mail: green seal@green seal.org
Internet: <https://www.green seal.org/>

GYPSUM ASSOCIATION (GA)
962 Wayne Ave., Suite 620
Silver Spring, MD 20910
Ph: 301-277-8686
Fax: 301-277-8747
E-mail: info@gypsum.org
Internet: <https://www.gypsum.org/>

HYDRAULIC INSTITUTE (HI)
6 Campus Drive, First Floor North
Parsippany, NJ 07054-4405
Ph: 973-267-9700
Fax: 973-267-9055
Internet: <http://www.pumps.org>

ICC EVALUATION SERVICE, INC. (ICC-ES)
3060 Saturn Street, Suite 100
Brea, CA 92821
Ph: 800-423-6587
Fax: 562-695-4694
E-mail: es@icc-es.org
Internet: <https://icc-es.org/>

ILLUMINATING ENGINEERING SOCIETY (IES)
120 Wall Street, Floor 17
New York, NY 10005-4001
Ph: 212-248-5000
Fax: 212-248-5018
E-mail: membership@ies.org
Internet: <https://www.ies.org/>

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
445 and 501 Hoes Lane
Piscataway, NJ 08854-4141
Ph: 732-981-0060 or 800-701-4333
Fax: 732-981-9667
E-mail: onlinesupport@ieee.org
Internet: <https://www.ieee.org/>

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
P.O. Box 493
Miamitown, OH 45041-9998
E-mail: info@icea.net
Internet: <https://www.icea.net/>

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)
27 N. Wacker Dr. Suite 365
Chicago, IL 60606-2800
Ph: 613-233-1510
Fax: 613-482-9436
E-mail: enquiries@igmaonline.org
Internet: <https://www.igmaonline.org/>

INTERNATIONAL CODE COUNCIL (ICC)
500 New Jersey Avenue, NW
6th Floor, Washington, DC 20001
Ph: 800-786-4452 or 888-422-7233
Fax: 202-783-2348
E-mail: order@iccsafe.org
Internet: <https://www.iccsafe.org/>

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)
1000 Westgate Drive, Suite 252
St. Paul, MN 55114
Ph: 651-366-6095
Fax: 651-290-2266
E-mail: info@icri.org
Internet: <https://www.icri.org/>

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)
3050 Old Centre Ave. Suite 101
Portage, MI 49024
Ph: 269-488-6382
Fax: 269-488-6383
Internet: <https://www.netaworld.org/>

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
ISO Central Secretariat
BIBC II
Chemin de Blandonnet 8
CP 401 - 1214 Vernier, Geneva
Switzerland
Ph: 41-22-749-01-11
E-mail: central@iso.ch
Internet: <https://www.iso.org>

INTERNET ENGINEERING TASK FORCE (IETF)
c/o Association Management Solutions, LLC (AMS)
5177 Brandin Court
Fremont, California 94538
Ph: 510-492-4080
Fax: 510-492-4001
E-mail: ietf-info@ietf.org
Internet: <https://www.ietf.org/>

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)
127 Park Street, NE
Vienna, VA 22180-4602
Ph: 703-281-6613
E-mail: info@msshq.org
Internet: <http://msshq.org>

MASTER PAINTERS INSTITUTE (MPI)
2800 Ingleton Avenue
Burnaby, BC CANADA V5C 6G7
Ph: 1-888-674-8937
Fax: 1-888-211-8708
E-mail: info@paintinfo.com or techservices@mpi.net
Internet: <http://www.mpi.net/>

METAL FRAMING MANUFACTURERS ASSOCIATION (MFMA)
330 N. Wabash Avenue
Chicago, IL 60611
Ph: 312-644-6610
E-mail: MFMAstats@smithbucklin.com
Internet: <http://www.metalframingmfg.org/>

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)
16712 Elm Circle
Omaha, NE 68130
Ph: 402-342-3463 or 800-747-6422
Fax: 402-330-9702
Internet: <https://www.micainsulation.org/>

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)
800 Roosevelt Road, Bldg C, Suite 312
Glen Ellyn, IL 60137
Ph: 630-942-6591
Fax: 630-790-3095
E-mail: info@naamm.org
Internet: <http://www.naamm.org>

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)
1055 Crupper Avenue
Columbus, OH 43229-1183
Ph: 614-888-8320
Fax: 614-888-0750
E-mail: information@nationalboard.org
Internet: <https://www.nationalboard.org>

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)
3 Bethesda Metro Center, Suite 1100
Bethesda, MD 20814
Ph: 301-657-3110
Fax: 301-215-4500
Internet: <https://www.necanet.org/>

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
1300 North 17th Street, Suite 900
Arlington, VA 22209
Ph: 703-841-3200
Internet: <https://www.nema.org>

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)
8575 Grovemont Circle
Gaithersburg, MD 20877
Ph: 301-977-3698
Fax: 301-977-9589
Internet: <http://www.nebb.org>

NATIONAL FENESTRATION RATING COUNCIL (NFRC)
6305 Ivy Lane, Suite 140
Greenbelt, MD 20770
Ph: 301-589-1776
Fax: 301-589-3884
E-Mail: info@nfrc.org
Internet: <http://www.nfrc.org>

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
1 Batterymarch Park
Quincy, MA 02169-7471
Ph: 800-344-3555
Fax: 800-593-6372
Internet: <https://www.nfpa.org>

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES
(NICET)
1420 King Street
Alexandria, VA 22314-2794
Ph: 888-476-4238 (1-888 IS-NICET)
E-mail: tech@nicet.org
Internet: <https://www.nicet.org/>

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)
100 Bureau Drive
Gaithersburg, MD 20899
Ph: 301-975-2000
Internet: <https://www.nist.gov/>

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)
10255 West Higgins Road, Suite 600
Rosemont, IL 60018-5607
Ph: 847-299-9070
Fax: 847-299-1183
Internet: <http://www.nrca.net>

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>

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
1776 I Street, NW, Suite 450
Washington, DC 20006
Ph: 202-785-6323
E-mail: washington.contact@oecd.org

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)
800 Roosevelt Road
Building C, Suite 312
Glen Ellyn, IL 60137
Ph: 630-858-6540
Fax: 630-790-3095
Internet: <https://www.ppfahome.org/>

PLUMBING AND DRAINAGE INSTITUTE (PDI)
800 Turnpike Street, Suite 300
North Andover, MA 01845
Ph: 978-557-0720 or 800-589-8956
E-Mail: pdi@PDIONline.org
Internet: <http://www.pdionline.org>

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)
200 West Adams St., 2100
Chicago, IL 60606
Ph: 312-786-0300
Bookstore: 312-428-4946
Internet: <https://www.pci.org/>

PROGRAMME FOR ENDORSEMENT OF FOREST CERTIFICATION (PEFC)
10, Route de l'Aéroport
Case Postale 638
1215 Geneva - Switzerland
Ph: +41 (22) 799-4540
Fax: +41 (22) 799-4550
Internet: <https://www.pefc.org/>

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)
2000 Powell Street, Suite 600
Emeryville, CA 94608
Ph: 510-452-8000
Fax: 510-452-8001
E-mail: info@SCSglobalservices.com
Internet: <https://www.scsglobalservices.com/>

SCREEN MANUFACTURERS ASSOCIATION (SMA)
Ph: 773-636-0672
E-mail: Kathryn@SMAinfo.org
Internet: <http://smainfo.org>

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)
4201 Lafayette Center Drive
Chantilly, VA 20151-1219
Ph: 703-803-2980
Fax: 703-803-3732
Internet: <https://www.smacna.org/>

SOCIETY FOR PROTECTIVE COATINGS (SSPC)
800 Trumbull Drive
Pittsburgh, PA 15205
Ph: 877-281-7772 or 412-281-2331
Fax: 412-444-3591
E-mail: customerservice@sspc.org
Internet: <http://www.sspc.org>

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)
400 Commonwealth Drive
Warrendale, PA 15096
Ph: 877-606-7323 or 724-776-4841
Fax: 724-776-0790
E-mail: customerservice@sae.org
Internet: <https://www.sae.org/>

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)
21865 Copley Drive
Diamond Bar, CA 91765
Ph: 909-396-2000
E-mail: webinquiry@aqmd.gov
Internet: <http://www.aqmd.gov>

SOUTHERN PINE INSPECTION BUREAU (SPIB)
P.O. Box 10915
Pensacola, FL 32524-0915
Ph: 850-434-2611 or 800-995-7742
Fax: 850-434-1290
E-mail: spib@spib.org
Internet: <https://www.spib.org/>

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NCDOT)
1 South Wilmington Street
Raleigh, NC 27601
phone: 877-368-4968
Internet:

STEEL DECK INSTITUTE (SDI)
P.O. Box 426
Glenshaw, PA 15116
Ph: 412-487-3325
Fax: 412-487-3326
Internet: <https://www.sdi.org/>

STEEL DOOR INSTITUTE (SDI/DOOR)
30200 Detroit Road
Westlake, OH 44145
Ph: 440-899-0010
Fax: 440-892-1404
E-mail: info@steeldoors.org
Internet: <https://www.steeldoors.org/>

SUSTAINABLE FOREST INITIATIVE (SFI)
2121 K Street NW
Suite 750
Washington, DC 20037
Ph: 202-596-3450
Fax: 202-596-3451
E-mail: info@sfiprogram.org
Internet: <http://www.sfiprogram.org>

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)
15 Technology Parkway South, Suite 115
Peachtree Corners, GA 30092
Ph: 800-332-8686 or 770-446-1400
Fax: 770-446-6947
E-mail: memberconnection@tappi.org

Internet: <http://www.tappi.org>

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)
1320 North Courthouse Road, Suite 200
Arlington, VA 22201
Ph: 703-907-7700
Fax: 703-907-7727
E-mail: marketing@tiaonline.org
Internet: <https://www.tiaonline.org/>

THE MASONRY SOCIETY (TMS)
105 South Sunset Street, Suite Q
Longmont, CO 80501-6172
Ph: 303-939-9700
Fax: 303-541-9215
E-mail: info@masonrysociety.org
<https://masonrysociety.org/>

TILE COUNCIL OF NORTH AMERICA (TCNA)
100 Clemson Research Boulevard
Anderson, SC 29625
Ph: 864-646-8453
Fax: 864-646-2821
E-mail: info@tileusa.com
Internet: <https://www.tcnatile.com/>

TURFGRASS PRODUCERS INTERNATIONAL (TPI)
444 E. Roosevelt Road
#346
Lombard, IL 60148
Ph: 800-405-8873 or 847-649-5555
Fax: 847-649-5678
E-mail: info@turfgrasssod.org
Internet: <http://www.turfgrasssod.org>

U.S. ARMY CORPS OF ENGINEERS (USACE)
CRD-C DOCUMENTS available on Internet:
<http://www.wbdg.org/ffc/army-coe/standards>
Order Other Documents from:
Official Publications of the Headquarters, USACE
E-mail: hqpublications@usace.army.mil
Internet: <http://www.publications.usace.army.mil/>
or
<https://www.hnc.usace.army.mil/Missions/Engineering-Directorate/TECHINFO/>

U.S. DEFENSE LOGISTICS AGENCY (DLA)
Andrew T. McNamara Building
8725 John J. Kingman Road
Fort Belvoir, VA 22060-6221
Ph: 877-352-2255
E-mail: dlacontactcenter@dla.mil
Internet: <http://www.dla.mil>

U.S. DEPARTMENT OF AGRICULTURE (USDA)
Order AMS Publications from:
AGRICULTURAL MARKETING SERVICE (AMS)
Seed Regulatory and Testing Branch
801 Summit Crossing Place, Suite C
Gastonia, NC 28054-2193

Ph: 704-810-8884
E-mail: PA@ams.usda.gov
Internet: <https://www.ams.usda.gov/>
Order Other Publications from:
USDA Rural Development
Rural Utilities Service
STOP 1510, Rm 5135
1400 Independence Avenue SW
Washington, DC 20250-1510
Phone: (202) 720-9540
Internet:
<https://www.rd.usda.gov/about-rd/agencies/rural-utilities-service>

U.S. DEPARTMENT OF DEFENSE (DOD)
Order DOD Documents from:
Room 3A750-The Pentagon
1400 Defense Pentagon
Washington, DC 20301-1400
Ph: 703-571-3343
Fax: 215-697-1462
E-mail: customerservice@ntis.gov
Internet: <https://www.ntis.gov/>
Obtain Military Specifications, Standards and Related Publications
from:
Acquisition Streamlining and Standardization Information System
(ASSIST)
Department of Defense Single Stock Point (DODSSP)
Document Automation and Production Service (DAPS)
Building 4/D
700 Robbins Avenue
Philadelphia, PA 19111-5094
Ph: 215-697-6396 - for account/password issues
Internet: <https://assist.dla.mil/online/start/>; account
registration required
Obtain Unified Facilities Criteria (UFC) from:
Whole Building Design Guide (WBDG)
National Institute of Building Sciences (NIBS)
1090 Vermont Avenue NW, Suite 700
Washington, DC 20005
Ph: 202-289-7800
Fax: 202-289-1092
Internet:
<https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc>

U.S. DEPARTMENT OF ENERGY (DOE)
1000 Independence Avenue Southwest
Washington, D.C. 20585
Ph: 202-586-5000
Fax: 202-586-4403
E-mail: The.Secretary@hq.doe.gov
Internet: <https://www.energy.gov/>

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)
1200 Pennsylvania Avenue, N.W.
Washington, DC 20004
Ph: 202-564-4700
Internet: <https://www.epa.gov>
--- Some EPA documents are available only from:
National Technical Information Service (NTIS)

5301 Shawnee Road
Alexandria, VA 22312
Ph: 703-605-6060 or 1-800-363-2068
Fax: 703-605-6880
TDD: 703-487-4639
E-mail: info@ntis.gov
Internet: <https://www.ntis.gov/>

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)
Order for sale documents from:
Superintendent of Documents
U.S. Government Publishing Office (GPO)
732 N. Capitol Street, NW
Washington, DC 20401
Ph: 202-512-1800 or 866-512-1800
Bookstore: 202-512-0132
Internet: <https://www.gpo.gov/>
Order free documents from:
U.S. Department of Transportation
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591
Ph: 866-835-5322
Internet: <https://www.faa.gov/>

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)
445 12th Street SW
Washington, DC 20554
Ph: 888-225-5322
TTY: 888-835-5322
Fax: 866-418-0232
Internet: <https://www.fcc.gov/>
Order Publications From:
Superintendent of Documents
U.S. Government Publishing Office (GPO)
732 N. Capitol Street, NW
Washington, DC 20401
Ph: 202-512-1800 or 866-512-1800
Bookstore: 202-512-0132
Internet: <https://www.gpo.gov/>

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)
1200 New Jersey Ave., SE
Washington, DC 20590
Ph: 202-366-4000
E-mail: ExecSecretariat.FHWA@dot.gov
Internet: <https://www.fhwa.dot.gov/>
Order from:
Superintendent of Documents
U.S. Government Publishing Office (GPO)
732 N. Capitol Street, NW
Washington, DC 20401
Ph: 202-512-1800 or 866-512-1800
Bookstore: 202-512-0132
Internet: <https://www.gpo.gov/>

U.S. GENERAL SERVICES ADMINISTRATION (GSA)
General Services Administration
1800 F Street, NW

Washington, DC 20405
Ph: 1-844-472-4111
Internet: <https://www.gsaelibrary.gsa.gov/ElibMain/home.do>
Obtain documents from:
Acquisition Streamlining and Standardization Information System
(ASSIST)
Internet: <https://assist.dla.mil/online/start/>; account
registration required

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
8601 Adelphi Road
College Park, MD 20740-6001
Ph: 866-272-6272
Internet: <https://www.archives.gov/>
Order documents from:
Superintendent of Documents
U.S. Government Publishing Office (GPO)
732 N. Capitol Street, NW
Washington, DC 20401
Ph: 202-512-1800 or 866-512-1800
Bookstore: 202-512-0132
Internet: <https://www.gpo.gov/>

UNDERWRITERS LABORATORIES (UL)
2600 N.W. Lake Road
Camas, WA 98607-8542
Ph: 877-854-3577 or 360-817-5500
E-mail: CustomerExperienceCenter@ul.com
Internet: <https://www.ul.com/>
UL Directories available through IHS at <https://ihsmarkit.com/>

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)
Corporate Headquarters
2711 LBJ Freeway, Suite 1000
Dallas, TX 75234
Ph: 972-243-3902
Fax: 972-243-3907
E-mail: info@uni-bell.org
Internet: <https://www.uni-bell.org/>

VIBRATION ISOLATION AND SEISMIC CONTROL MANUFACTURERS ASSOCIATION
(VISCMA)
994 Old Eagle School Road
Suite 1019
Wayne, PA 19087-1866
Ph: 610-971-4850
E-mail: info@viscma.com
Internet: <http://www.viscma.com>

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)
2025 M Street, NW, Suite 800
Washington, DC 20036-3309
Ph: 202-367-1157
or
330 N Wabash Avenue, Suite 2000
Chicago, IL 60611
Ph: 312-321-6802
E-mail: membersupport@wdma.com
Internet: <https://www.wdma.com/>

WOODWORK INSTITUTE (WI)
3188 Industrial Blvd.
West Sacramento, CA 95691
Ph: 916-372-9943
Fax: 916-372-9950
E-mail: info@woodinst.com
Internet: <https://woodworkinstitute.com>

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

-- End of Section --

SECTION 01 45 00.00 20

QUALITY CONTROL
11/11, CHG 8: 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 in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 52.2 (2017) Method of Testing General
Ventilation Air-Cleaning Devices for
Removal Efficiency by Particle Size

ASTM INTERNATIONAL (ASTM)

ASTM D6245 (2012) Using Indoor Carbon Dioxide
Concentrations to Evaluate Indoor Air
Quality and Ventilation

ASTM D6345 (2010) Standard Guide for Selection of
Methods for Active, Integrative Sampling
of Volatile Organic Compounds in Air

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

ANSI/SMACNA 008 (2007) IAQ Guidelines for Occupied
Buildings Under Construction, 2nd Edition

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval.. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-01 Preconstruction Submittals

Construction Quality Control (QC) Plan; G

Indoor Air Quality (IAQ) Management Plan; G

1.3 INFORMATION FOR THE CONTRACTING OFFICER

Prior to commencing work on construction, the Contractor can obtain a single copy set of the current report forms from the Contracting Officer.

The report forms will consist of the Contractor Production Report, Contractor Production Report (Continuation Sheet), Contractor Quality Control (CQC) Report, CQC Report (Continuation Sheet), Preparatory Phase Checklist, Initial Phase Checklist, Rework Items List, and Testing Plan and Log.

Deliver the following to the Contracting Officer during Construction:

- a. CQC Report: Submit the report electronically by 10:00 AM the next working day after each day that work is performed and for every seven consecutive calendar days of no-work.
- b. Contractor Production Report: Submit the report electronically by 10:00 AM the next working day after each day that work is performed and for every seven consecutive calendar days of no-work.
- c. Preparatory Phase Checklist: Submit the report electronically in the same manner as the CQC Report for each Preparatory Phase held.
- d. Initial Phase Checklist: Submit the report electronically in the same manner as the CQC Report for each Initial Phase held.
- f. Field Test Reports: Within two working days after the test is performed, submit the report as an electronic attachment to the CQC Report.
- g. Monthly Summary Report of Tests: Submit the report as an electronic attachment to the CQC Report at the end of each month.
- h. Testing Plan and Log: Submit the report as an electronic attachment to the CQC Report, at the end of each month. Provide a copy of the final Testing Plan and Log to the preparer of the Operation & Maintenance (O&M) documentation.
- i. Rework Items List: Submit lists containing new entries daily, in the same manner as the CQC Report.
- j. CQC Meeting Minutes: Within two working days after the meeting is held, submit the report as an electronic attachment to the CQC Report.
- k. QC Certifications: As required by the paragraph QC CERTIFICATIONS.
- l. Special Inspection Report: Submit the Special Inspection reports, in the same manner as the CQC Report.

1.4 QC PROGRAM REQUIREMENTS

Establish and maintain a QC program as described in this section. This QC program is a key element in meeting the objectives of NAVFAC Commissioning. The QC program consists of a QC Organization, QC Plan, QC Plan Meeting(s), a Coordination and Mutual Understanding Meeting, QC meetings, three phases of control, submittal review and approval, testing, completion inspections, QC certifications, independent Special Inspections in accordance with Section 01 45 35 SPECIAL INSPECTIONS, and documentation necessary to provide materials, equipment, workmanship, fabrication, construction and operations which comply with the requirements of this Contract. The QC program must cover on-site and off-site work and be keyed to the work sequence. No construction work or testing may be performed unless the QC Manager is on the work site. The QC Manager must

report to an officer of the firm and not be subordinate to the Project Superintendent or the Project Manager. The QC Manager, Project Superintendent and Project Manager must work together effectively. Although the QC Manager is the primary individual responsible for quality control, all individuals will be held responsible for the quality of work on the job.

1.4.1 Commissioning

Commissioning (Cx) is a systematic process of ensuring that all building systems meet the requirements and perform interactively according to the Contract. The QC Program is a key in supporting the objectives of the Cx process, specifically to coordinate, document, and verify compliance with contract requirements. Refer to commissioning requirements in Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING.

1.4.2 Acceptance of the Construction Quality Control (QC) Plan

Acceptance of the QC Plan is required prior to the start of construction. The Contracting Officer reserves the right to require changes in the QC Plan and operations as necessary, including removal of personnel, to ensure the specified quality of work. The Contracting Officer reserves the right to interview any member of the QC organization at any time in order to verify the submitted qualifications. All QC organization personnel are subject to acceptance by the Contracting Officer. The Contracting Officer may require the removal of any individual for non-compliance with quality requirements specified in the Contract.

1.4.3 Preliminary Construction Work Authorized Prior to Acceptance

The only construction work that is authorized to proceed prior to the acceptance of the QC Plan is mobilization of storage and office trailers, temporary utilities, and surveying.

1.4.4 Notification of Changes

Notify the Contracting Officer, in writing, of any proposed changes in the QC Plan or changes to the QC organization personnel, a minimum of 10 work days prior to a proposed change. Proposed changes are subject to acceptance by the Contracting Officer.

1.4.5 Special Inspections

Perform all required Special Inspections per Section 01 45 35 SPECIAL INSPECTIONS, the statement of Special Inspections and the Schedule of Special Inspections.

1.5 QC ORGANIZATION

1.5.1 QC Manager

1.5.1.1 Duties

Provide a QC Manager at the work site to implement and manage the QC program. The only duties and responsibilities of the QC Manager are to manage and implement the QC program on this Contract. The QC Manager is required to attend the partnering meetings, QC Plan Meetings, Coordination

and Mutual Understanding Meeting, conduct the QC meetings, perform the three phases of control, perform submittal review and approval, ensure testing is performed and provide QC certifications and documentation required in this Contract. The QC Manager is responsible for managing and coordinating the three phases of control and documentation performed by testing laboratory personnel and any other inspection and testing personnel required by this Contract. The QC Manager is the manager of all QC activities. The QC manager is responsible for notifying the Special Inspector of activities which require their review. The QC manager is responsible for coordinating the Special Inspection activities, see paragraph QUALITY CONTROL MANAGER, in Section 01 45 35 SPECIAL INSPECTIONS.

1.5.1.1.1 Additional Quality Control (QC) Manager Requirements and Duties

The Quality Control (QC) Manager may not serve as the SSHO. The Quality Control (QC) Manager may not serve as the Superintendent.

1.5.1.2 Qualifications

An individual with a minimum of 5 years combined experience in the following positions: Project Superintendent, QC Manager, Project Manager, Project Engineer or Construction Manager on similar size and type construction contracts which included the major trades that are part of this Contract. The individual must have at least two years experience as a QC Manager. The individual must be familiar with the requirements of EM 385-1-1, and have experience in the areas of hazard identification, safety compliance, and sustainability.

1.5.2 Lead Commissioning Specialist (Cx/C)

Provide the Lead Commissioning Specialist (Cx/C) as key person for the commissioning requirements in Section 01 91 00.15.20 TOTAL BUILDING COMMISSIONING.

1.5.3 Construction Quality Management Training

In addition to the above experience and education requirements, the QC Manager must have completed the course entitled "Construction Quality Management (CQM) for Contractors." If the QC Manager does not have a current certification, they must obtain the CQM for Contractors course certification within 90 days of award. This course is periodically offered by the Naval Facilities Engineering Command and the Army Corps of Engineers. Contact the Contracting Officer for information on the next scheduled class.

1.5.4 Alternate QC Manager Duties and Qualifications

Designate an alternate for the QC Manager at the work site to serve in the event of the designated QC Manager's absence. The period of absence may not exceed two weeks at one time, and not more than 30 workdays during a calendar year. The qualification requirements for the Alternate QC Manager must be the same as for the QC Manager.

1.5.5 Special Inspector

The Special Inspector (SI) must be an independent third party hired directly by the Prime Contractor. The SI must not be a company employee of the Contractor or any Sub-Contractor performing the work to be inspected. The qualifications of the SI are defined in Section 01 45 35

SPECIAL INSPECTION.

1.6 QUALITY CONTROL (QC) PLAN

1.6.1 Construction Quality Control (QC) Plan

Submit a Construction QC Plan prior to start of construction.

1.6.1.1 Requirements

Provide a Construction QC Plan, prior to start of construction, that includes a table of contents, with major sections identified, with pages numbered sequentially, and that documents the proposed methods and responsibilities for accomplishing quality control during the construction of the project:

- a. QC ORGANIZATION: A chart showing the QC organizational structure.
- b. NAMES AND QUALIFICATIONS: Names and qualifications, in resume format, for each person in the QC organization. Include the CQM for Contractors course certifications for the QC Manager and Alternate QC Manager as required by the paragraphs CONSTRUCTION QUALITY MANAGEMENT TRAINING and ALTERNATE QC MANAGER DUTIES AND QUALIFICATIONS.
- c. DUTIES, RESPONSIBILITY AND AUTHORITY OF QC PERSONNEL: Duties, responsibilities, and authorities of each person in the QC organization.
- d. OUTSIDE ORGANIZATIONS: A listing of outside organizations, such as architectural and consulting engineering firms, that will be employed by the Contractor and a description of the services these firms will provide.
- e. APPOINTMENT LETTERS: Letters signed by an officer of the firm appointing the QC Manager and Alternate QC Manager and stating that they are responsible for implementing and managing the QC program as described in this Contract. Include in this letter the responsibility of the QC Manager and Alternate QC Manager to implement and manage the three phases of control, and their authority to stop work which is not in compliance with the Contract. Letters of direction are to be issued by the QC Manager to all other QC Specialists outlining their duties, authorities, and responsibilities. Include copies of the letters in the QC Plan.
- f. SUBMITTAL PROCEDURES AND INITIAL SUBMITTAL REGISTER: Procedures for reviewing, approving, and managing submittals. Provide the name(s) of the person(s) in the QC organization authorized to review and certify submittals prior to approval. Provide the initial submittal of the Submittal Register as specified in Section 01 33 00 SUBMITTAL PROCEDURES.
- g. TESTING LABORATORY INFORMATION: Testing laboratory information required by the paragraphs ACCREDITATION REQUIREMENTS, as applicable.
- h. TESTING PLAN AND LOG: A Testing Plan and Log that includes the tests required, referenced by the specification paragraph number requiring the test, the frequency, and the person responsible for each test.
- i. PROCEDURES TO COMPLETE REWORK ITEMS: Procedures to identify, record,

track, and complete rework items.

- j. LIST OF DEFINABLE FEATURES: A Definable Feature of Work (DFOW) is a task that is separate and distinct from other tasks and has control requirements and work crews unique to that task. A DFOW is identified by different trades or disciplines and is an item or activity on the construction schedule. Include in the list of DFOWs, but not be limited to, all critical path activities on the NAS. Include all activities for which this specification requires QC Specialists or specialty inspection personnel. Provide separate DFOWs in the Network Analysis Schedule for each design development stage and submittal package.
- k. PROCEDURES FOR PERFORMING THE THREE PHASES OF CONTROL: Identify procedures used to ensure the three phases of control to manage the quality on this project. For each DFOW, a Preparatory and Initial phase checklist will be filled out during the Preparatory and Initial phase meetings. Conduct the Preparatory and Initial Phases and meetings with a view towards obtaining quality construction by planning ahead and identifying potential problems for each DFOW.
- l. PERSONNEL MATRIX: Not Applicable
- m. PROCEDURES FOR COMPLETION INSPECTION: Procedures for identifying and documenting the completion inspection process. Include in these procedures the responsible party for punch out inspection, pre-final inspection, and final acceptance inspection.
- n. TRAINING PROCEDURES AND TRAINING LOG: Procedures for coordinating and documenting the training of personnel required by the Contract.
- o. ORGANIZATION AND PERSONNEL CERTIFICATIONS LOG: Procedures for coordinating, tracking and documenting all certifications on subcontractors, testing laboratories, suppliers, personnel, etc. QC Manager will ensure that certifications are current, appropriate for the work being performed, and will not lapse during any period of the contract that the work is being performed.

1.7 COORDINATION AND MUTUAL UNDERSTANDING MEETING

After submission of the QC Plan, and prior to Government approval and the start of construction, the QC Manager will meet with the Contracting Officer to present the QC program required by this Contract. When a new QC Manager is appointed, the coordination and mutual understanding meeting must be repeated.

1.7.1 Purpose

The purpose of this meeting is to develop a mutual understanding of the QC details, including documentation, administration for on-site and off-site work, design intent, Cx in accordance with Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING, environmental requirements and procedures, coordination of activities to be performed, Special Inspections, and the coordination of the Contractor's management, production, and QC personnel. At the meeting, the Contractor will be required to explain in detail how three phases of control will be implemented for each DFOW, as well as how each DFOW will be affected by each management plan or requirement as listed below:

- a. Waste Management Plan.
- b. IAQ Management Plan.
- c. Procedures for noise and acoustics management.
- d. Environmental Protection Plan.
- e. Environmental regulatory requirements.
- f. Cx Plan requirements in accordance with Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING.
- g. Special Inspections.

1.7.2 Coordination of Activities

Coordinate activities included in various sections to assure efficient and orderly installation of each component. Coordinate operations included under different sections that are dependent on each other for proper installation and operation. Schedule construction operations with consideration for indoor air quality as specified in the IAQ Management Plan. Coordinate special inspections.

1.7.3 Attendees

As a minimum, the Contractor's personnel required to attend include an officer of the firm, the Project Manager, Project Superintendent, QC Manager, Alternate QC Manager, Special Inspector, CxC, Environmental Manager, and subcontractor representatives. Each subcontractor who will be assigned QC responsibilities must have a principal of the firm at the meeting. Minutes of the meeting will be prepared by the QC Manager and signed by the Contractor and the Contracting Officer. Provide a copy of the signed minutes to all attendees and include in the QC Plan.

1.8 QC MEETINGS

After the start of construction, conduct weekly QC meetings by the QC Manager at the work site with the Project Superintendent, the Special Inspector, CxC, and the foremen who are performing the work of the DFOWs. The QC Manager is to prepare the minutes of the meeting and provide a copy to the Contracting Officer within two working days after the meeting. The Contracting Officer may attend these meetings. As a minimum, accomplish the following at each meeting:

- a. Review the minutes of the previous meeting.
- b. Review the schedule and the status of work and rework.
- c. Review the status of submittals.
- d. Review the work to be accomplished in the next two weeks and documentation required.
- e. Resolve QC and production problems (RFI, etc.).
- f. Address items that may require revising the QC Plan.
- g. Review Accident Prevention Plan (APP).

- h. Review environmental requirements and procedures.
- i. Review Waste Management Plan.
- j. Review IAQ Management Plan.
- k. Review Environmental Management Plan.
- l. Review the status of training completion.
- m. Review Cx requirements in accordance with Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING.

1.9 THREE PHASES OF CONTROL

Adequately cover both on-site and off-site work with the Three Phases of Control and include the following for each DFOV.

1.9.1 Preparatory Phase

Notify the Contracting Officer at least two work days in advance of each preparatory phase meeting. The meeting will be conducted by the QC Manager and attended by the Project Superintendent, the CxC, the Special Inspector, and the foreman responsible for the DFOV. When the DFOV will be accomplished by a subcontractor, that subcontractor's foreman must attend the preparatory phase meeting. Document the results of the preparatory phase actions in the Preparatory Phase Checklist. Perform the following prior to beginning work on each DFOV:

- a. Review each paragraph of the applicable specification sections.
- b. Review the Contract drawings.
- c. Verify that field measurements are as indicated on construction and/or shop drawings before confirming product orders, in order to minimize waste due to excessive materials.
- d. Verify that appropriate shop drawings and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required.
- e. Review the testing plan and ensure that provisions have been made to provide the required QC testing.
- f. Review special inspections required by Section 01 45 35 SPECIAL INSPECTION, the statement of special inspections and the schedule of special inspections.
- g. Examine the work area to ensure that the required preliminary work has been completed.
- h. Coordinate the schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- i. Arrange for the return of shipping/packaging materials, such as wood pallets, where economically feasible.

- j. Examine the required materials, equipment and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data and are properly stored.
- k. Discuss specific controls used and construction methods, construction tolerances, workmanship standards, and the approach that will be used to provide quality construction by planning ahead and identifying potential problems for each DFOV.
- l. Review the APP and appropriate Activity Hazard Analysis (AHA) to ensure that applicable safety requirements are met, and that required Safety Data Sheets (SDS) are submitted.
- m. Review the Cx requirements in accordance with Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING.

1.9.2 Initial Phase

Notify the Contracting Officer at least two work days in advance of each initial phase. When construction crews are ready to start work on a DFOV, conduct the initial phase with the Project Superintendent, the Special Inspector, and the foreman responsible for that DFOV. Observe the initial segment of the DFOV to ensure that the work complies with Contract requirements. Document the results of the initial phase in the daily CQC Report and in the Initial Phase Checklist. Repeat the initial phase for each new crew to work on-site, or when acceptable levels of specified quality are not being met. Perform the following for each DFOV:

- a. Establish level of workmanship and verify that it meets the minimum acceptable workmanship standards. Compare with required sample panels as appropriate.
- b. Resolve any workmanship issues.
- c. Ensure that testing is performed by the approved laboratory.
- d. Check work procedures for compliance with the APP and the appropriate AHA to ensure that applicable safety requirements are met.
- e. Review project specific work plans (i.e. Cx, HAZMAT Abatement, Stormwater Management) to ensure all preparatory work items have been completed and documented.
- f. Coordinate scheduled work with special inspections required by Section 01 45 35 SPECIAL INSPECTIONS, the statement of special inspections and the schedule of special inspections.

1.9.3 Follow-Up Phase

Perform the following for on-going work daily, or more frequently as necessary, until the completion of each DFOV and document in the daily CQC Report:

- a. Ensure the work is in compliance with Contract requirements.
- b. Maintain the quality of workmanship required.
- c. Ensure that testing is performed by the approved laboratory.

- d. Ensure that rework items are being corrected.
- e. Assure manufacturers representatives have performed necessary inspections if required and perform safety inspections.
- f. Review the Cx requirements in accordance with Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING.
- g. Coordinate scheduled work with special inspections required by Section 01 45 35 SPECIAL INSPECTIONS, the statement of special inspections and the schedule of special inspections.

1.9.4 Additional Preparatory and Initial Phases

Conduct additional preparatory and initial phases on the same DFOW if the quality of on-going work is unacceptable, if there are changes in the applicable QC organization, if there are changes in the on-site production supervision or work crew, if work on a DFOW is resumed after substantial period of inactivity, or if other problems develop.

1.9.5 Notification of Three Phases of Control for Off-Site Work

Notify the Contracting Officer at least two weeks prior to the start of the preparatory and initial phases.

1.10 SUBMITTAL REVIEW AND APPROVAL

Procedures for submission, review and approval of submittals are described in Section 01 33 00 SUBMITTAL PROCEDURES.

1.11 TESTING

Except as stated otherwise in the specification sections, perform sampling and testing required under this Contract.

1.11.1 Accreditation Requirements

Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate ASTM standards (E 329, C 1077, D 3666, D 3740, E 543) listed in the technical sections of the specifications. Laboratories engaged in Hazardous Materials Testing must meet the requirements of OSHA and EPA. The policy applies to the specific laboratory performing the actual testing, not just the Corporate Office.

1.11.2 Laboratory Accreditation Authorities

Laboratory Accreditation Authorities include the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the National Institute of Standards and Technology at <https://www.nist.gov/nvlap>, the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program at <http://www.aashtoresource.org/aap/overview>, International Accreditation Services, Inc. (IAS) at <http://www.iasonline.org>, U.S. Army Corps of Engineers Materials Testing Center (MTC) at <http://www.erdc.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/9254/Article/476661/materials-testing-center.aspx>, the American

Association for Laboratory Accreditation (A2LA) program at <http://www.a2la.org/>, the Washington Association of Building Officials (WABO) at <http://www.wabo.org/> (Approval authority for WABO is limited to projects within Washington State), and the Washington Area Council of Engineering Laboratories (WACEL) at <https://www.wacel.org/lab-accreditation-and-inspection-agency-audit-programs/laboratory-accreditation-program/> (Approval authority by WACEL is limited to projects within Facilities Engineering Command (FEC) Washington geographical area).

1.11.3 Capability Check

The Contracting Officer retains the right to check laboratory equipment in the proposed laboratory and the laboratory technician's testing procedures, techniques, and other items pertinent to testing, for compliance with the standards set forth in this Contract.

1.11.4 Test Results

Cite applicable Contract requirements, tests or analytical procedures used. Provide actual results and include a statement that the item tested or analyzed conforms or fails to conform to specified requirements. If the item fails to conform, notify the Contracting Officer immediately. Conspicuously stamp the cover sheet for each report in large red letters "CONFORMS" or "DOES NOT CONFORM" to the specification requirements, whichever is applicable. Test results must be signed by a testing laboratory representative authorized to sign certified test reports. Furnish the signed reports, certifications, and other documentation to the Contracting Officer via the QC Manager. Furnish a summary report of field tests at the end of each month, in accordance with paragraph INFORMATION FOR THE CONTRACTING OFFICER.

1.11.5 Test Reports and Monthly Summary Report of Tests

Furnish the signed reports, certifications, and a summary report of field tests at the end of each month to the Contracting Officer. Attach a copy of the summary report to the last daily Contractor Quality Control Report of each month. Provide a copy of the signed test reports and certifications to the OMSI preparer for inclusion into the OMSI documentation, in accordance with Sections 01 78 23 OPERATION AND MAINTENANCE DATA.

1.12 QC CERTIFICATIONS

1.12.1 CQC Report Certification

Contain the following statement within the CQC Report: "On behalf of the Contractor, I certify that this report is complete and correct and equipment and material used and work performed during this reporting period is in compliance with the contract drawings and specifications to the best of my knowledge, except as noted in this report."

1.12.2 Invoice Certification

Furnish a certificate to the Contracting Officer with each payment request, signed by the QC Manager, attesting that as-built drawings are current, coordinated and attesting that the work for which payment is requested, including stored material, is in compliance with Contract requirements.

1.12.3 Completion Certification

Upon completion of work under this Contract, the QC Manager must furnish a certificate to the Contracting Officer attesting that "the work has been completed, inspected, tested and is in compliance with the Contract." Provide a copy of this final QC Certification for completion to the preparer of the Operation & Maintenance (O&M) documentation.

1.13 COMPLETION INSPECTIONS

1.13.1 Punch-Out Inspection

Near the completion of all work or any increment thereof, established by a completion time stated in the Contract Clause entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the QC Manager must conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved drawings, specifications and Contract. Include in the punch list any remaining items on the "Rework Items List", which were not corrected prior to the Punch-Out Inspection. Include within the punch list the estimated date by which the deficiencies will be corrected. Provide a copy of the punch list to the Contracting Officer. The QC Manager, or staff, must make follow-on inspections 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".

1.13.2 Pre-Final Inspection

The Government and QC Manager will perform this inspection to verify that the facility is complete and ready to be occupied. A Government "Pre-Final Punch List" will be documented by the QC Manager as a result of this inspection. The QC Manager will ensure that all items on this list are corrected prior to notifying the Government that a "Final" inspection with the Client can be scheduled. Any items noted on the "Pre-Final" inspection must be corrected in a timely manner and be accomplished before the contract completion date for the work, or any particular increment thereof, if the project is divided into increments by separate completion dates.

1.13.3 Final Acceptance Inspection

Notify the Contracting Officer at least 14 calendar days prior to the date a final acceptance inspection can be held. State within the notice that all items previously identified on the pre-final punch list will be corrected and acceptable, along with any other unfinished Contract work, by the date of the final acceptance inspection. The Contractor must be represented by the QC Manager, the Project Superintendent and others deemed necessary. Attendees for the Government will include the Contracting Officer, other FEAD/ROICC personnel, and personnel representing the Client. 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 entitled "Inspection of Construction."

1.14 DOCUMENTATION

Maintain current and complete records of on-site and off-site QC program

operations and activities.

1.14.1 Construction Documentation

Reports are required for each day that work is performed and must be attached to the Contractor Quality Control Report prepared for the same day. Maintain current and complete records of on-site and off-site QC program operations and activities. The forms identified under the paragraph "INFORMATION FOR THE CONTRACTING OFFICER" will be used. Reports are required for each day work is performed. Account for each calendar day throughout the life of the Contract. Every space on the forms must be filled in. Use N/A if nothing can be reported in one of the spaces. The Project Superintendent and the QC Manager must prepare and sign the Contractor Production and CQC Reports, respectively. The reporting of work must be identified by terminology consistent with the construction schedule. In the "remarks" sections of the reports, enter pertinent information including directions received, problems encountered during construction, work progress and delays, conflicts or errors in the drawings or specifications, field changes, safety hazards encountered, instructions given and corrective actions taken, delays encountered and a record of visitors to the work site, quality control problem areas, deviations from the QC Plan, construction deficiencies encountered, meetings held. For each entry in the report(s), identify the Schedule Activity No. that is associated with the entered remark.

1.14.2 Quality Control Validation

Establish and maintain the following in an electronic folder. Divide folder into a series of tabbed sections as shown below. Ensure folder is updated at each required progress meeting.

- a. All completed Preparatory and Initial Phase Checklists, arranged by specification section.
- b. All milestone inspections, arranged by Activity Number.
- c. An up-to-date copy of the Testing Plan and Log with supporting field test reports, arranged by specification section.
- d. Copies of all contract modifications, arranged in numerical order. Also include documentation that modified work was accomplished.
- e. An up-to-date copy of the Rework Items List.
- f. Maintain up-to-date copies of all punch lists issued by the QC staff to the Contractor and Sub-Contractors and all punch lists issued by the Government.
- g. Cx documentation in accordance with Section 01 91 00.15 20 TOTAL BUILDING COMMISSIONING.
- h. Special inspection reports.

1.14.3 Testing Plan and Log

As tests are performed, the CxC and the QC Manager will record on the "Testing Plan and Log" the date the test was performed and the date the test results were forwarded to the Contracting Officer. Attach a copy of the updated "Testing Plan and Log" to the last daily CQC Report of each

month, per the paragraph "INFORMATION FOR THE CONTRACTING OFFICER".
Provide a copy of the final "Testing Plan and Log" to the preparer of the
Operation & Maintenance (O&M) documentation.

1.14.4 Rework Items List

The QC Manager must maintain a list of work that does not comply with the Contract, identifying what items need to be reworked, the date the item was originally discovered, the date the item will be corrected by, and the date the item was corrected. There is no requirement to report a rework item that is corrected the same day it is discovered. Attach a copy of the "Rework Items List" to the last daily CQC Report of each month. The Contractor is responsible for including those items identified by the Contracting Officer.

1.14.5 As-Built Drawings

The QC Manager is required to ensure the as-built drawings, required by Section 01 78 00 CLOSEOUT SUBMITTALS are kept current on a daily basis and marked to show deviations which have been made from the Contract drawings. Ensure each deviation has been identified with the appropriate modifying documentation (e.g. PC No., Modification No., Request for Information No., etc.). The QC Manager must initial each revision. Upon completion of work, the QC Manager will furnish a certificate attesting to the accuracy of the as-built drawings prior to submission to the Contracting Officer.

1.15 NOTIFICATION ON NON-COMPLIANCE

The Contracting Officer will notify the Contractor of any detected non-compliance with the Contract. Take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, is deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may 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 for excess costs or damages by the Contractor.

1.16 CONSTRUCTION INDOOR AIR QUALITY (IAQ) MANAGEMENT PLAN

Submit an IAQ Management Plan within 15 calendar days after notice to proceed and not less than 10 calendar days before the preconstruction meeting. Revise and resubmit Plan as required by the Contracting Officer. Make copies of the final plan available to all workers on site. Include provisions in the Plan to meet the requirements specified below and to ensure safe, healthy air for construction workers and building occupants.

1.16.1 Requirements During Construction

Provide for evaluation of indoor Carbon Dioxide concentrations in accordance with ASTM D6245. Provide for evaluation of volatile organic compounds (VOCs) in indoor air in accordance with ASTM D6345. Use filters with a Minimum Efficiency Reporting Value (MERV) of 8 in permanently installed air handlers during construction.

1.16.1.1 Control Measures

Meet or exceed the requirements of [ANSI/SMACNA 008](#), Chapter 3, to help minimize contamination of the building from construction activities. The five requirements of this manual which must be adhered to are described below:

- a. HVAC protection: Isolate return side of HVAC system from surrounding environment to prevent construction dust and debris from entering the duct work and spaces.
- b. Source control: Use low emitting paints and other finishes, sealants, adhesives, and other materials as specified. When available, cleaning products must have a low VOC content and be non-toxic to minimize building contamination. Utilize cleaning techniques that minimize dust generation. Cycle equipment off when not needed. Prohibit idling motor vehicles where emissions could be drawn into building. Designate receiving/storage areas for incoming material that minimize IAQ impacts.
- c. Pathway interruption: When pollutants are generated use strategies such as 100 percent outside air ventilation or erection of physical barriers between work and non-work areas to prevent contamination.
- d. Housekeeping: Clean frequently to remove construction dust and debris. Promptly clean up spills. Remove accumulated water and keep work areas dry to discourage the growth of mold and bacteria. Take extra measures when hazardous materials are involved.
- e. Scheduling: Control the sequence of construction to minimize the absorption of VOCs by other building materials.

1.16.1.2 Moisture Contamination

- a. Remove accumulated water and keep work dry.
- b. Use dehumidification to remove moist, humid air from a work area.
- c. Do not use combustion heaters or generators inside the building.
- d. Protect porous materials from exposure to moisture.
- e. Remove and replace items which remain damp for more than a few hours.

1.16.2 Requirements after Construction

After construction ends and prior to occupancy, conduct a building flush-out or test the indoor air contaminant levels. Flush-out must be a minimum two-weeks with MERV-13 filtration media as determined by [ASHRAE 52.2](#) at 100 percent outside air. Air contamination testing must be consistent with EPA's current Compendium of Methods for the Determination of Air Pollutants in Indoor Air. After building flush-out or testing and prior to occupancy, replace filtration media. Filtration media must have a MERV of 13 as determined by [ASHRAE 52.2](#).

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PREPARATION

Designate receiving/storage areas for incoming material to be delivered according to installation schedule and to be placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. Store and handle materials in a manner as to prevent loss from weather and other damage. Keep materials, products, and accessories covered and off the ground, and store in a dry, secure area. Prevent contact with material that may cause corrosion, discoloration, or staining. Protect all materials and installations from damage by the activities of other trades.

-- End of Section --

SECTION 01 45 35

SPECIAL INSPECTIONS

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.

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC

(2021) International Building Code

1.2 GENERAL REQUIREMENTS

Perform Special Inspections in accordance with the Statement of Special Inspections, Schedule of Special Inspections and Chapter 17 of ICC IBC. The Statement of Special Inspections and Schedule of Special Inspections are included as an attachment to this specification. Special Inspections are to be performed by an independent third party and are intended to ensure that the work of the Prime Contractor is in accordance with the Contract Documents and applicable building codes. Special inspections do not take the place of the three phases of control inspections performed by the Contractor's QC Manager or any testing and inspections required by other sections of the specifications.

1.3 DEFINITIONS

1.3.1 Continuous Special Inspections

Continuous Special Inspections is the constant monitoring of specific tasks by a special inspector. These inspections must be carried out continuously over the duration of the particular tasks.

1.3.2 Perform

Perform these Special Inspections tasks for each welded joint or member.

1.3.3 Observe

Observe these Special Inspections items on a periodic daily basis. Operations need not be delayed pending these inspections.

1.3.4 Special Inspector (SI)

A qualified person retained by the Contractor and approved by the Contracting Officer as having the competence necessary to inspect a particular type of construction requiring Special Inspections. The SI must be an independent third party hired directly by the Prime Contractor.

1.3.5 Associate Special Inspector (ASI)

A qualified person who assists the SI in performing Special Inspections but must perform inspection under the direct supervision of the SI and

cannot perform inspections without the SI on site.

1.3.6 Third Party

A Special inspector must not be an employee of the Contractor or of any Sub-Contractor performing the work to be inspected.

1.3.7 Contracting Officer

The Government official having overall authority for administrative contracting actions. Certain contracting actions may be delegated to the Contracting Officer's Representative (COR).

1.3.8 Contractor's Quality Control (QC) Manager

An individual retained by the Prime Contractor and qualified in accordance with the Section 01 45 00.00 20 QUALITY CONTROL having the overall responsibility for the Contractor's QC organization.

1.3.9 Structural Engineer of Record (SER)

A registered design professional responsible for the overall design and review of submittal documents prepared by others. The SER is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws in the state in which the design professional works. The SER is also referred to as the Engineer of Record (EOR) in design code documents.

1.3.10 Statement of Special Inspections (SSI)

A document developed by the SER identifying the material, systems, components and work required to have Special Inspections. This statement is included at the end of this specification.

1.3.11 Schedule of Special Inspections (SSI)

A schedule which lists each of the required Special Inspections, the extent to which each Special Inspection is to be performed, and the required frequency for each in accordance with ICC IBC Chapter 17. This schedule is included at the end of this specification.

1.3.12 Definable Feature of Work (DFOW)

An inspection group that is separate and distinct from other inspection groups, having inspection requirements or inspectors that are unique.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Special Inspections Agency's [Written NDT Practices](#) with method and evidence of regular equipment calibration where applicable

[SD-06 Test Reports](#)

Special Inspections [Daily Reports](#)

Special Inspections [Biweekly Reports](#)

[SD-07 Certificates](#)

[AISC Certified Steel Fabricator](#)

[Steel Joist Institute Membership](#)

[Certificate of Compliance](#)

[Special Inspector Qualifications](#); [G](#)

[Qualification Records](#) for NDT technicians

[SD-11 Closeout Submittals](#)

[Interim Report](#) of Special Inspections for Each DFO; [G](#)

[Comprehensive Final Report](#) of Special Inspections; [G](#)

1.5 SPECIAL INSPECTOR QUALIFICATIONS

Submit qualifications for each [special inspector](#).

1.5.1 Steel Construction and High Strength Bolting

1.5.1.1 Special Inspector

- a. ICC Structural Steel and Bolting Special Inspector certificate with one year of related experience, or
- b. Registered Professional Engineer with three years of related experience

1.5.1.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.2 Welding Structural Steel

1.5.2.1 Special Inspector

- a. ICC Structural Welding Special Inspector certificate with one year of related experience, or

b. AWS Certified Welding Inspector

1.5.2.2 Associate Special Inspector

AWS Certified Associate Welding Inspector

1.5.3 Nondestructive Testing of Welds

1.5.3.1 Special Inspector

NDT Level III Certificate

1.5.3.2 Associate Special Inspector

NDT Level II Certificate plus one year of related experience

1.5.4 Cold Formed Steel Framing

1.5.4.1 Special Inspector

- a. ICC Structural Steel and Bolting Special Inspector certificate with one year of related experience, or
- b. ICC Commercial Building Inspector with one year of experience, or
- c. ICC Residential Building Inspector with one year of experience, or
- d. Registered Professional Engineer with three years related experience

1.5.4.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.5 Concrete Construction

1.5.5.1 Special Inspector

- a. ICC Reinforced Concrete Special Inspector Certificate with one year of related experience, or
- b. ACI Concrete Construction Special Inspector, or
- c. Registered Professional Engineer with three years of related experience

1.5.5.2 Associate Special Inspector

- a. ACI Concrete Construction Special Inspector in Training, or
- b. Engineer-In-Training with one year of related experience

1.5.6 Prestressed Concrete Construction

1.5.6.1 Special Inspector

- a. ICC Pre-stressed Special Inspector Certificate with one year of related experience, or
- b. PCI Quality Control Technician/ Inspector Level II Certificate with

one year of related experience, or

- c. Registered Professional Engineer with three years of related experience

1.5.6.2 Associate Special Inspector

- a. PCI Quality Control Technician/ Inspector Level I Certificate with one year of related experience, or
- b. Engineer-In-Training with one year of related experience

1.5.7 Post-tensioned Concrete Construction

1.5.7.1 Special Inspector

- a. PTI Level 2 Unbonded PT Inspector Certificate, or
- b. Registered Professional Engineer with three years of related experience

1.5.7.2 Associate Special Inspector

- a. PTI Level 1 Unbonded PT Inspector Certificate with one year of related experience, or
- b. Engineer-In-Training with one year of related experience

1.5.8 Masonry Construction

1.5.8.1 Special Inspector

- a. ICC Structural Masonry Special Inspector Certificate with one year of related experience, or
- b. Registered Professional Engineer with three years of related experience

1.5.8.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.9 Wood

1.5.9.1 Special Inspector

- a. ICC Commercial Building Inspector Certificate with one year of related experience, or
- b. ICC Residential Building Inspector with one year of experience, or
- c. Registered Professional Engineer with three years of related experience

1.5.9.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.10 Verification of Site Soil Condition, Fill Placement and
Load-Bearing Requirements

1.5.10.1 Special Inspector

- a. ICC Soils Special Inspector Certificate with one year of related experience, or
- b. NICET Soils Technician Level II Certificate in Construction Material Testing, or
- c. Geologist-In-Training with three years of related experience, or
- d. Registered Professional Engineer with three years of related experience

1.5.10.2 Associate Special Inspector

- a. NICET Soils Technician Level I Certificate in Construction Material Testing with one year of related experience, or
- b. Engineer-In-Training with one year of related experience

1.5.11 Deep Foundations

1.5.11.1 Special Inspector

- a. NICET Soils Technician Level II Certificate in Construction Material Testing, or
- b. Geologist-In-Training with three years of related experience, or
- c. Registered Professional Engineer with three years of related experience

1.5.11.2 Associate Special Inspector

- a. NICET Soils Technician Level I Certificate in Construction Material Testing with one year of related experience, or
- b. NICET Geotechnical Engineering Technician Level I Construction or Generalist Certificate with one year of related experience, or
- c. Engineer-In-Training with one year of related experience

1.5.12 Sprayed Fire Resistant Material

1.5.12.1 Special Inspector

- a. ICC Spray-applied Fireproofing Special Inspector Certificate, or
- b. ICC Fire Inspector I Certificate with one year of related experience, or
- c. Registered Professional Engineer or Architect with related experience

1.5.12.2 Associate Special Inspector

Engineer-In-Training with one year of related experience

1.5.13 Mastic and Intumescent Fire Resistant Coatings

1.5.13.1 Special Inspector

- a. ICC Spray-applied Fireproofing Special Inspector Certificate, or
- b. ICC Fire Inspector I Certificate with one year of related experience, or
- c. Registered Professional Engineer or Architect with related experience

1.5.13.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.14 Exterior Insulation and Finish System (EIFS)

1.5.14.1 Special Inspector

- a. AWCI EIFS Inspector Certificate, or
- b. Exterior Design Institute Certificate, or
- c. Registered Professional Engineer or Architect with related experience

1.5.14.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.15 Fire-Resistant Penetrations and Joints

1.5.15.1 Special Inspector

- a. Passed the UL Firestop Exam with one year of related experience, or
- b. Passed the FM Firestop Exam with one year of related experience, or
- c. Registered Professional Engineer with related experience

1.5.15.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.16 Smoke Control

1.5.16.1 Special Inspector

- a. AABC Technician Certification with one year of related experience, or
- b. Registered Professional Engineer with related experience

1.5.16.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

PART 2 PRODUCTS

2.1 FABRICATOR SPECIAL INSPECTIONS

Special Inspections of fabricator's work performed in the fabricator's shop is required to be inspected in accordance with the Statement of Special Inspections and the Schedule of Special Inspections unless the fabricator is certified by the approved agency to perform such work without Special Inspections. Submit the following certification certifications to the Contracting Officer for information to allow work performed in the fabricator's shop to not be subjected to Special Inspections.

[AISC Certified Steel Fabricator.](#)

[Steel Joist Institute Membership](#)

At the completion of fabrication, submit a [certificate of compliance](#), to be included with the comprehensive final report of Special Inspections, stating that the materials supplied and work performed by the fabricator are in accordance with the construction documents.

PART 3 EXECUTION

3.1 RESPONSIBILITIES

3.1.1 Quality Control Manager

- a. Supervise all Special Inspectors required by the Contract Documents and the IBC.
- b. Verify the qualifications of all of the Special Inspectors.
- c. Verify the qualifications of fabricators.
- d. Maintain a 3-ring binder for the Special Inspector's daily and [biweekly reports](#). This file must be located in a conspicuous place in the project trailer/office to allow review by the Contracting Officer and the SER.

Maintain a rework items list that includes discrepancies noted on the Special Inspectors daily report.

3.1.2 Special Inspectors

- a. Inspect all elements of the project for which the special inspector is qualified to inspect and are identified in the Schedule of Special Inspections.
- b. Attend preparatory phase meetings related to the Definable Feature of Work (DFOW) for which the special inspector is qualified to inspect.
- c. Submit Special Inspections agency's [written NDT practices](#) for the monitoring and control of the agency's operations to include the following:
 - (1) The agency's procedures for the selection and administration of inspection personnel, describing the training, experience and

examination requirements for qualifications and certification of inspection personnel.

- (2) The agency's inspection procedures, including general inspection, material controls, and visual welding inspection.
- d. Submit [qualification records](#) for nondestructive testing (NDT) technicians designated for the project.
- e. Submit NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.
- f. Submit a copy of the [daily reports](#) to the QC Manager.
- g. Report discrepancies that are observed during Special Inspections to the QC Manager for correction. If discrepancies are not corrected before the special inspector leaves the site the observed discrepancies must be documented in the daily report.
- h. Submit a biweekly Special Inspection Report until all inspections are complete. A report is required for each biweekly period in which Special Inspections activity occurs, and must include the following:
 - (1) A brief summary of the work performed during the reporting time frame.
 - (2) Changes and discrepancies with the drawings, specifications and mechanical or electrical component certification, that were observed during the reporting period.
 - (3) Discrepancies which were resolved or corrected.
 - (4) A list of nonconforming items requiring resolution.
 - (5) All applicable test result including nondestructive testing reports.
- i. At the completion of each DFOV requiring Special Inspections, submit an [interim report](#) of Special Inspections that documents the Special Inspections completed for that DFOV. Identify the inspector responsible for each item inspected and corrections of all discrepancies noted in the daily reports. The interim report of Special Inspections must be signed, dated and indicate the certification of the special inspector qualifying them to conduct the inspection.
- j. At the completion of the project submit a [comprehensive final report](#) of Special Inspections that documents the Special Inspections completed for the project and corrections of all discrepancies noted in the daily reports. The comprehensive final report of Special Inspections must be signed, dated and indicate the certification of the special inspector qualifying them to conduct the inspection.

3.2 DEFECTIVE WORK

Check work as it progresses, but failure to detect any defective work or materials must in no way prevent later rejection if defective work or materials are discovered, nor obligate the Contracting Officer to accept such work.

-- End of Section --

SCHEDULE OF SPECIAL INSPECTIONS

Reference UFGS 01 45 35 for all requirements not noted as part of this schedule.

INSPECTION DEFINITIONS:

- PERFORM:** Perform these tasks for each weld, fastener or bolted connection, and noted verification.
- OBSERVE:** Observe these items randomly during the course of each work day to insure that applicable requirements are being met. Operations need not be delayed pending these inspections at contractor's risk.
- DOCUMENT:** Document, with a report, that the work has been performed in accordance with the contract documents. This is in addition to any other reports required in the Special Inspections guide specification.
- CONTINUOUS:** Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

The Seismic Design Category for this project is: ☐ A, ☒ B, ☐ C, ☐ D, ☐ E, ☐ F (check appropriate box)

STRUCTURAL - STEEL – WELDING SECTION

ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED: ☒

STEEL INSPECTION <u>PRIOR TO</u> WELDING – VERIFY THE FOLLOWING ARE IN COMPLIANCE 2018 IBC 1705.2.1, AISC 360-16: Table C-N5.4-1		
TASK	INSPECTION TYPE ¹	DESCRIPTION
1. Verify that the welding procedures specification (WPS) is available	PERFORM	
2. Verify manufacturer certifications for welding consumables are available	PERFORM	
3. Verify material identification	PERFORM	Type and grade.
4. Welder Identification System	PERFORM	The fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress type.
5. Fit-up of groove welds (including joint geometry)	OBSERVE	<ul style="list-style-type: none"> ✓ Joint preparation ✓ Dimensions (alignment, root opening, root face, bevel) ✓ Cleanliness (condition of steel surfaces) ✓ Tacking (tack weld quality and location)

¹ **PERFORM:** Perform these tasks for each weld, fastener or bolted connection, and required verification.

OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

		✓ Backing type and fit (if applicable)
6. Configuration and finish of access holes	OBSERVE	
7. Fit-up of fillet welds	OBSERVE	✓ Dimensions (alignment, gaps at root) ✓ Cleanliness (condition of steel surfaces) ✓ Tacking (tack weld quality and location)
STEEL INSPECTION <u>DURING</u> WELDING – VERIFY THE FOLLOWING ARE IN COMPLIANCE 2018 IBC 1705.2.1, AISC 360-16: Table C-N5.4-2		
TASK	INSPECTION TYPE	DESCRIPTION
8. Use of qualified welders	PERFORM	Welding by welders, welding operators, and tack welders who are qualified in conformance with requirements.
9. Control and handling of welding consumables	OBSERVE	✓ Packaging ✓ Electrode atmospheric exposure control
10. No welding over cracked tack welds	OBSERVE	
11. Environmental conditions	OBSERVE	✓ Wind speed within limits ✓ Precipitation and temperature
12. Welding Procedures Specification followed	OBSERVE	✓ Settings on welding equipment ✓ Travel speed ✓ Selected welding materials ✓ Shielding gas type/flow rate ✓ Preheat applied ✓ Interpass temperature maintained (min./max.) ✓ Proper position (F, V, H, OH) ✓ Intermix of filler metals avoided
13. Welding techniques	OBSERVE	✓ Interpass and final cleaning ✓ Each pass within profile limitations ✓ Each pass meets quality requirements

STRUCTURAL - STEEL – WELDING SECTION (CONTINUED)

STEEL INSPECTION AFTER WELDING – VERIFY THE FOLLOWING ARE IN COMPLIANCE 2018 IBC 1705.2.1, AISC 360-16: Table C-N5.4-3		
TASK	INSPECTION TYPE ¹	DESCRIPTION
14. Welds cleaned	OBSERVE	
15. Size, length, and location of all welds	PERFORM	Size, length, and location of all welds conform to the requirements of the detail drawings.
16. Welds meet visual acceptance criteria	PERFORM AND DOCUMENT	<ul style="list-style-type: none"> ✓ Crack prohibition ✓ Weld/base-metal fusion ✓ Crater cross section ✓ Weld profiles ✓ Weld size ✓ Undercut ✓ Porosity
17. Arc strikes	PERFORM	
18. k-area	PERFORM	When welding of doubler plates, continuity plates or stiffeners has been performed in the k-area, visually inspect the web k-area for cracks.
19. Backing removed, weld tabs removed and finished, and fillet welds added where required	PERFORM	
20. Repair activities	PERFORM AND DOCUMENT	
21. Document acceptance or rejection of welded joint or member	PERFORM	

END SECTION

¹ **PERFORM:** Perform these tasks for each weld, fastener or bolted connection, and required verification.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

STRUCTURAL - STEEL – BOLTING SECTION**ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED: ☒**

STEEL INSPECTION TASKS PRIOR TO BOLTING – VERIFY THE FOLLOWING ARE IN COMPLIANCE 2018 IBC 1705.2.1, AISC 360-16: Table C-N5.6-1		
TASK	INSPECTION TYPE ¹	DESCRIPTION
1. Manufacturer's certifications available for fastener materials	PERFORM	
2. Fasteners marked in accordance with ASTM requirements	OBSERVE	
3. Proper fasteners selected for joint detail (grade, type, bolt length if threads are to be excluded from shear plane)	OBSERVE	
4. Proper bolting procedure selected for joint detail	OBSERVE	
5. Connecting elements, including appropriate faying surface condition and hole preparation, if specified, meet applicable requirements	OBSERVE	
6. Proper storage provided for bolts, nuts, washers, and other fastener components	OBSERVE	
STEEL INSPECTION TASKS DURING BOLTING – VERIFY THE FOLLOWING ARE IN COMPLIANCE 2018 IBC 1705.2.1, AISC 360-16: Table C-N5.6-2		
TASK	INSPECTION TYPE ¹	DESCRIPTION
7. Fastener assemblies of suitable condition, placed in all holes and washers (if required) are positioned as required	OBSERVE	
8. Joint brought to the snug-tight condition prior to pretensioning operation	OBSERVE	
9. Fastener component not turned by the wrench prevented from rotating	OBSERVE	
10. Bolts are pretensioned in accordance with RCSC Specification, progressing systematically from the most rigid point toward the free edges	OBSERVE	
STEEL INSPECTION TASKS AFTER BOLTING – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.2.1, AISC 360-10: Table C-N5.6-3		
TASK	INSPECTION TYPE ¹	DESCRIPTION
11. Document acceptance or rejection of all bolted connections	DOCUMENT	

END SECTION

¹ **PERFORM:** Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

STRUCTURAL - STEEL - NON DESTRUCTIVE TESTING SECTION**ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED: ☒**

NONDESTRUCTIVE TESTING OF WELDED JOINTS – VERIFY THE FOLLOWING ARE IN COMPLIANCE 2018 IBC 1705.2.1, AISC 360-16: Section N5.5		
TASK	INSPECTION TYPE ¹	DESCRIPTION
1. Use of qualified nondestructive testing personnel	PERFORM	Visual weld inspection and nondestructive testing (NDT) shall be conducted by personnel qualified in accordance with AWS D1.8 clause 7.2
2. CJP groove welds	OBSERVE	Dye penetrant testing (DT) and ultrasonic testing (UT) shall be performed on 100% of CJP groove welds for materials greater than 5/16" (8mm) thick.

END SECTION**STRUCTURAL - STEEL - COMPOSITE CONSTRUCTION ²****ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED: ☐**

COMPOSITE CONSTRUCTION PRIOR TO PLACING CONCRETE – VERIFY THE FOLLOWING ARE IN COMPLIANCE 2018 IBC 1705.2.1, AISC 360-16: Table N6.1, AISC 341-16: Table J9.1		
TASK	INSPECTION TYPE ²	DESCRIPTION
1. Placement and installation of steel headed stud anchors	PERFORM	
2. Material identification of reinforcing steel (Type/Grade)	OBSERVE	
3. Determination of carbon equivalent for reinforcing steel other than ASTM A706	OBSERVE	
4. Proper reinforcing steel size, spacing, clearances, support, and orientation	OBSERVE	
5. Reinforcing steel has not been re-bent in the field	OBSERVE	
6. Reinforcing clearances have been provided	OBSERVE	
7. Reinforcing steel has been tied and supported as required	OBSERVE	
8. Composite member has required size	OBSERVE	

END SECTION

¹ **PERFORM:** Perform these tasks for each weld, fastener or bolted connection, and required verification.

OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

² See Concrete Construction Section for all concrete related inspection of composite steel construction.

STRUCTURAL - STEEL - OTHER INSPECTIONS**ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED: ☒**

OTHER STEEL INSPECTIONS – VERIFY THE FOLLOWING ARE IN COMPLIANCE 2018 IBC 1705.2.1, AISC 341-16: Tables J8.1 & J10.1		
TASK	INSPECTION TYPE ¹	DESCRIPTION
1. Anchor rods and other embedments supporting structural steel	PERFORM	Verify the diameter, grade, type, and length of the anchor rod or embedded item, and the extent or depth of embedment prior to placement of concrete.
2. Fabricated steel or erected steel frame	OBSERVE	Verify compliance with the details shown on the construction documents, such as braces, stiffeners, member locations and proper application of joint details at each connection.
3. Reduced beam sections (RBS) where/if occurs	DOCUMENT	✓ Contour and finish ✓ Dimensional tolerances
4. Protected zones	DOCUMENT	No holes or unapproved attachments made by fabricator or erector

END SECTION**STRUCTURAL - COLD-FORMED METAL DECK - PLACEMENT SECTION****ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED: ☒**

METAL DECK INSPECTION <u>PRIOR TO</u> DECK PLACEMENT – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.1		
TASK	INSPECTION TYPE ²	DESCRIPTION
1. Verify compliance of materials (deck and all deck accessories) with construction documents, including profiles, material properties, and base metal thickness	PERFORM	
2. Document acceptance or rejection of deck and deck accessories	DOCUMENT	
METAL DECK INSPECTION <u>DURING</u> DECK PLACEMENT – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.2		
TASK	INSPECTION TYPE ¹	DESCRIPTION
3. Verify compliance of deck and all deck accessories installation with construction documents	PERFORM	
4. Verify deck materials are represented by the mill	PERFORM	

¹ **PERFORM:** Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

² **PERFORM:** Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

certifications that comply with the construction documents		
5. Document acceptance or rejection of installation of deck and deck accessories	DOCUMENT	
METAL DECK INSPECTION <u>AFTER</u> DECK PLACEMENT – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.3		
TASK	INSPECTION TYPE ¹	DESCRIPTION
6. Welding procedure specification (WPS) available	PERFORM	
7. Manufactures certifications for welding consumables available	OBSERVE	
8. Material identification (type/grade)	OBSERVE	
9. Check welding equipment	OBSERVE	

END SECTION**STRUCTURAL - COLD-FORMED METAL DECK – WELDING SECTION****ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED:** ☒

METAL DECK INSPECTION <u>DURING</u> WELDING – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.4		
TASK	INSPECTION TYPE ¹	DESCRIPTION
1. Use of qualified welders	OBSERVE	
2. Control and handling of welding consumables	OBSERVE	
3. Environmental conditions (wind speed, moisture, temperature)	OBSERVE	
4. WPS followed	OBSERVE	
METAL DECK INSPECTION <u>AFTER</u> WELDING – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.5		
TASK	INSPECTION TYPE ¹	DESCRIPTION
5. Verify size and location of welds, including support, sidelap, and perimeter welds.	PERFORM	
6. Welds meet visual acceptance criteria	PERFORM	
7. Verify repair activities	PERFORM	
8. Document acceptance or rejection of welds	DOCUMENT	

END SECTION

¹ **PERFORM:** Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

STRUCTURAL - COLD-FORMED METAL DECK – FASTENING SECTION**ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED: ☒**

METAL DECK INSPECTION <u>BEFORE</u> MECHANICAL FASTENING – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.6		
TASK	INSPECTION TYPE ¹	DESCRIPTION
1. Manufacturer installation instructions available for mechanical fasteners	OBSERVE	
2. Proper tools available for fastener installation	OBSERVE	
METAL DECK INSPECTION <u>DURING</u> MECHANICAL FASTENING – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.7		
TASK	INSPECTION TYPE ¹	DESCRIPTION
3. Fasteners are positioned as required	OBSERVE	
4. Fasteners are installed in accordance with manufacturer's instructions	OBSERVE	
METAL DECK INSPECTION <u>AFTER</u> MECHANICAL FASTENING – VERIFY THE FOLLOWING ARE IN COMPLIANCE SDI QA/QC-2011, Appendix 1, Table 1.8		
TASK	INSPECTION TYPE ¹	DESCRIPTION
5. Check spacing, type, and installation of support fasteners	PERFORM	
6. Check spacing, type, and installation of sidelap fasteners	PERFORM	
7. Check spacing, type, and installation of perimeter fasteners	PERFORM	
8. Verify repair activities	PERFORM	
9. Document acceptance or rejection of mechanical fasteners	DOCUMENT	

END SECTION

¹ **PERFORM:** Perform these tasks for each weld, fastener or bolted connection, and required verification.
OBSERVE: Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.
DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

STRUCTURAL - OPEN-WEB STEEL JOISTS SECTION**ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED:** ☐

OPEN-WEB STEEL JOISTS AND JOIST GIRDERS – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC TABLE 1705.2.3		
TASK	INSPECTION TYPE ¹	DESCRIPTION
1. Installation of open-web steel joists and joist girders	OBSERVE	✓ End connections – welded or bolted ✓ Bridging – horizontal and diagonal

END SECTION**STRUCTURAL - CONCRETE CONSTRUCTION SECTION****ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED:** ☒

CONCRETE CONSTRUCTION, INCLUDING COMPOSITE DECK – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC TABLE 1705.3 (ACI 318 REFERENCES NOTED IN IBC TABLE)		
TASK	INSPECTION TYPE ¹	DESCRIPTION
1. Inspect reinforcement, including prestressing tendons, and verify placement.	OBSERVE	Verify prior to placing concrete that reinforcing is of specified type, grade and size; that it is free of oil, dirt and unacceptable rust; that it is located and spaced properly; that hooks, bends, ties, stirrups and supplemental reinforcement are placed correctly; that lap lengths, stagger and offsets are provided; and that all mechanical connections are installed per the manufacturer's instructions and/or evaluation report.
2. Reinforcing bar welding	OBSERVE	✓ Verify weldability of reinforcing bars other than ASTM A 706 ✓ Inspect single-pass fillet welds, maximum 5/16" in accordance with AWS D1.4
3. All other welding	CONTINUOUS	Visually inspect all welds in accordance with AWS D1.4
4. Cast in place anchors and post installed drilled anchors (downward inclined)	OBSERVE	Verify prior to placing concrete that cast in place anchors and post installed drilled anchors have proper embedment, spacing and edge distance.
5. Post-installed adhesive anchors in horizontal or upward inclined orientations	CONTINUOUS AND DOCUMENT	✓ Inspect as required per approved ICC-ES report ✓ Verify that installer is certified for installation of horizontal and overhead installation applications ✓ Inspect proof loading as required by the contract documents
6. Verify use of required mix design	OBSERVE	Verify that all mixes used comply with the approved construction documents
7. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete	CONTINUOUS	At the time fresh concrete is sampled to fabricate specimens for strength test verify these tests are performed by qualified technicians.

¹ **OBSERVE:** Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

CONTINUOUS: Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

8. Inspect concrete and/or shotcrete placement for proper application techniques	CONTINUOUS	Verify proper application techniques are used during concrete conveyance and depositing avoids segregation or contamination. Verify that concrete is properly consolidated.
9. Verify maintenance of specified curing temperature and technique	OBSERVE	Inspect curing, cold weather protection, and hot weather protection procedures.

CONTINUED ON FOLLOWING PAGE

STRUCTURAL - CONCRETE CONSTRUCTION (CONTINUED)

CONCRETE CONSTRUCTION, INCLUDING COMPOSITE DECK – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC TABLE 1705.3 (ACI 318 REFERENCES NOTED IN IBC TABLE)		
TASK	INSPECTION TYPE ¹	DESCRIPTION
10. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	OBSERVE	
11. Inspect formwork for shape, location and dimensions of the concrete member being formed.	OBSERVE	

END SECTION

¹ **OBSERVE:** Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

DOCUMENT: Document in a report that the work has been performed as required. This is in addition to all other required reports.

CONTINUOUS: Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

STRUCTURAL - MASONRY CONSTRUCTION SECTION (ALL RISK CATEGORIES)**ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED: ☒**

MASONRY CONSTRUCTION – VERIFY THE FOLLOWING ARE IN COMPLIANCE <u>AT START</u> OF CONSTRUCTION IBC 1705.4 (ACI 530-13 TABLE 3.1.2 & 3.1.3)		
TASK	INSPECTION TYPE ¹	DESCRIPTION
1. Compliance with approved submittals prior to start	OBSERVE	
2. Proportions of site-mixed mortar.	OBSERVE	
3. Grade and type of reinforcement, anchor bolts, and prestressing tendons and anchorages	OBSERVE	
MASONRY CONSTRUCTION – VERIFY THE FOLLOWING ARE IN COMPLIANCE <u>PRIOR TO</u> GROUTING IBC 1705.4 (ACI 530-13 TABLE 3.1.2 & 3.1.3)		
TASK	INSPECTION TYPE ¹	DESCRIPTION
4. Grout space	OBSERVE	
5. Proportions of site-prepared grout	OBSERVE	
6. Proportions of site-mixed grout	OBSERVE	
7. Placement of masonry units and mortar joints	OBSERVE	
8. Welding of reinforcement	CONTINUOUS	
MASONRY CONSTRUCTION – VERIFY THE FOLLOWING ARE IN COMPLIANCE <u>DURING</u> CONSTRUCTION IBC 1705.4 (ACI 530-13 TABLE 3.1.2 & 3.1.3)		
TASK	INSPECTION TYPE ¹	DESCRIPTION
9. Size and location of structural elements is in compliance	OBSERVE	
10. Preparation, construction, and protection of masonry during cold weather (temperature below 40°F (4.4°C) or hot weather (temp above 90°F (32.2°C))	OBSERVE	
11. Placement of grout	CONTINUOUS	
12. Observe preparation of grout specimens, mortar specimens, and/or prisms	OBSERVE	
13. Type, size and placement of reinforcement, connectors, anchor bolts and prestressing tendons and anchorages, including details of anchorage of masonry to structural members, frames, or other construction	OBSERVE	

END SECTION

¹ **OBSERVE:** Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

CONTINUOUS: Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

GEOTECHNICAL - SOILS INSPECTION SECTION**ALL OR PORTIONS OF THIS SECTION ARE APPLICABLE IF BOX IS CHECKED: ☒**

SOILS INSPECTION – VERIFY THE FOLLOWING ARE IN COMPLIANCE IBC 1705.6		
TASK	INSPECTION TYPE ¹	DESCRIPTION
1. Materials below shallow foundations are adequate to achieve the design bearing capacity.	OBSERVE	
2. Excavations are extended to proper depth and have reached proper material	OBSERVE	
3. Perform classification and testing of compacted fill materials	OBSERVE	
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill	CONTINUOUS	
5. Prior to placement of compacted fill, inspect subgrade and verify that site has been prepared properly.	OBSERVE	During fill placement, the special inspector shall verify that proper materials and procedures are used in accordance with the provisions of the approved geotechnical report

END SECTION

¹ **OBSERVE:** Observe these items on a random sampling basis daily to insure that applicable requirements are met. Operations need not be delayed pending these inspections at contractor's risk.

CONTINUOUS: Constant monitoring of identified tasks by a special inspector over the duration of performance of said tasks.

Project: P-1594 BUILDING RR1
Location: Camp Lejeune, NC
Project #: Eproject #7159437
Date: 11/13/2022



STATEMENT OF SPECIAL INSPECTIONS

Project Seismic Design Category: B
Project Risk Category: II
Project Design Wind Speed (mph): 144
Number of Stories: 2
Structure Height Above Grade (ft): 22
Hazardous Occupancy or attached to such? No Group H Occupancies

Special Inspector of Record (SIOR)

A Special Inspector of Record (SIOR) IS NOT required (per UFGS 01 45 35, Section 1.3.8)

Lateral Force Resisting System (LFRS)

2018 IBC 1704.3.2 and 1704.3.3

Following is a listing of critical main wind/seismic force resisting systems for this structure. Carefully inspect these elements as part of the roles and responsibilities of the Special Inspector (reference the Schedule of Special Inspections for inspection checklists).

Vertical LFRS Elements	Notes
<u>Light-Gauge Metal Stud Bearing Walls and Steel Frame</u>	<u>Both orthogonal directions. See plan for call out.</u>
Horizontal LFRS Elements	Notes
<u>Metal Roof Deck & Related Fastening System</u>	<u>Roof & Typical Details</u>

Designated Seismic Systems (DSS)

(2018 IBC 1705.13.3) (ASCE 7-16, 13.2.2, C13.2.2) (UFC 3-301-1, 2-5.3)

DESIGNATED SEISMIC SYSTEMS DO NOT APPLY TO THIS PROJECT, due to the Seismic Design Category being less than C.

Final Walk Down Inspection and Report

(UFC 3 301 01 SECTION 2-5.4)

Final Walk Down Inspection of non-structural Designated Seismic Systems does not apply to this project (no Designated Seismic Systems)

This page is intentionally left blank.

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

07/21

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.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C511 (2017) Reduced-Pressure Principle Backflow
Prevention Assembly

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

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00, "Submittal Procedures."

SD-03 Product Data

Backflow preventers

SD-06 Test Reports

Backflow Preventer Tests

SD-07 Certificates

Backflow Tester Certifications

Backflow Preventers Certificate of Full Approval

1.3 BACKFLOW TESTER CERTIFICATIONS

Certificate of Full Approval from FCCCHR List, University of Southern California, attesting that the design, size and make of each backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. Certificate of Provisional Approval will not be acceptable.

1.3.1 Backflow Preventers Certificate

The Contractor shall submit a certificate recognized by the State or local authority that states the Contractor has completed at least 10 hours of training in backflow preventer installations. The certificate must be current.

1.4 TEMPORARY UTILITIES

1.4.1 Availability of Utility Services

- a. The Contract clause related to utilities applies. Reasonable amounts of water and electricity from the nearest outlet will be provided free of charge for pursuance of work within a facility under this contract. If the nearest available outlet cannot be utilized by the Contractor because of improper voltage, insufficient current, improper pressure, incompatible connectors, etc., it shall be the responsibility of the Contractor to provide temporary utilities as required.
- b. Reasonable amounts of utilities for contractor trailers and storage buildings will be made available to the Contractor, when available. The Contractor shall be responsible for providing transformers, electrical service poles and drops for electrical services, and backflow preventer devices on connections to domestic water lines. Final taps and tie-ins to the Government utility grid will be made by the Contractor after approval by the Contracting Officer. Tap-in cost, if any, shall be the responsibility of the Contractor. Under no circumstances will taps to base fire hydrants be allowed for obtaining domestic water.

1.4.2 Trailers

Electrical service will be supplied by the Government, when available, except at Tarawa Terrace where Carolina Power and Light Company will be the supplier.

1.4.3 Energy and Utilities Conservation

The Contractor shall carefully conserve utilities furnished without charge. The Contractor, at his own expense and in a manner satisfactory to the Contracting Officer, shall install and maintain all necessary temporary connections and distribution lines and remove the same prior to final acceptance of the construction.

1.4.4 Location of Underground Utilities

Location and Protection of underground utilities shall be the responsibility of the Contractor. Where existing-to-remain piping, utilities, and underground obstructions of any type are indicted in locations to be traversed by new piping, ducts, and other excavations the elevations of the existing utilities and obstructions shall be determined before the new work is completed.

- a. In addition, the Contractor will be responsible for obtaining the services of a professional utility locator prior to digging. Contractor will provide documentation that the site has been surveyed and checked for underground utilities. All utilities must be located, including but not limited to power, water, sewer,

storm drains, fiber optics, T.V. cable, telephone, and intrusion detection wiring. A set of known utility drawings will be available in the ROICC office for review to assist the locator.

- b. It is mandatory that the Contractor also contact the Base Telephone Office (451-2531) prior to accomplishing any digging at Camp Lejeune. A telephone office representative will assist in locating telephone lines.
- c. It is mandatory that the Contractor also contact Charter Communications, cable TV service prior to accomplishing any digging at Camp Lejeune, to ensure that all buried cable lines are identified. Contact Mr. Olin Criswell at 353-8677 for assistance.
- d. It is mandatory that the contractor also contact the North Carolina One-Call Center to coordinate the location of underground natural gas infrastructure. North Carolina 811, Inc. can be reached at 811 on a touch-tone phone in the state of North Carolina or toll-free at 1.800.632.4949 if calling from out of state. Work requests may also be submitted online at www.nc811.org.

1.4.4.1 The Locations of Underground Utilities

The locations of underground utilities shown at only approximate and the information provided may be incomplete. Contractor shall attempt to ascertain locations of existing underground utilities prior to and during digging operations.

1.4.4.2 Damage to Underground Utilities

Immediate notice shall be delivered to the Contracting Officer of any damage. The Contractor shall make temporary repairs immediately, and shall provide permanent repairs as soon as practicable. For any additional work required by reason of conflict between the new and existing work, an adjustment in contract price will be made in accordance with Contract clause entitled "Differing Site Conditions", if appropriate.

1.5 WEATHER PROTECTION

Take necessary precautions to ensure that roof openings and other critical openings in the building are monitored carefully. Take immediate actions required to seal off such openings when rain or other detrimental weather is imminent, and at the end of each workday. Ensure that the openings are completely sealed off to protect materials and equipment in the building from damage.

1.5.1 Building and Site Storm Protection

When a warning of gale force winds is issued, take precautions to minimize danger to persons, and protect the work and nearby Government property. Precautions shall include, but are not limited to, closing openings; removing loose materials, tools and equipment from exposed locations; and removing or securing scaffolding and other temporary work. Close openings in the work when storms of lesser intensity pose a threat to the work or any nearby Government property.

1.5.1.1 Hurricane Conditions of Readiness

Unless directed otherwise, comply with:

- a. Condition FIVE: Normal weather conditions are expected for the foreseeable future. No action is required.
- b. Condition FOUR (Sustained winds of 74 mph or greater expected within 72 hours): Contractors shall continue normal daily clean up and good house keeping practices. Collect and store in piles or containers scrap lumber, waste material, and rubbish for removal and disposal at the close of each work day. Stack lumber in neat piles less than 4 feet high. Prepare to remove or secure all debris, trash, or stored materials that could become missile hazards during high wind conditions. Meetings should be held on-site with all subcontractors to review the measures that are going to need to be taken should the base go to a higher readiness condition. Contact the ROICC for any additional updates and upon completion of all required actions.
- c. Condition THREE (Sustained winds of 74 mph or greater expected within 48 hours): Once Condition 3 is set, contractors shall shift their focus from their normal activities to taking the actions that are required to prepare the job site for the potential of destructive weather. All debris and rubbish shall be removed from the site at the end of the workday. All stored materials shall either be removed from the job site or secured (metal straps or heavy lines/ropes). All tools, equipment and gear shall be secured at the end of the workday. Begin preparations to adequately secure the facility (windows boarded up, etc.). Meetings should be held on-site with all subcontractors to review the measures that are going to be taken should base go to a higher readiness condition. Contract the ROICC for any additional updates and upon completion of all required actions.
- d. Condition TWO (Sustained winds of 74 mph or greater expected within 24 hours): Cease all normal activities until the job-site is completely prepared for the onslaught of destructive weather. The job site should be completely free of debris, rubbish and scrap materials. The facility being worked on should be made weather-tight. All scaffolding planking shall be removed. All formwork and free standing structural steel shall be braced. All machinery, tools, equipment and materials shall be properly secured or removed from the job-site. Expend every effort to clear all missiles hazards and loose equipment from the job site. When the contractor secures for the day the job site should be left in a condition that is ready for the storm and the contractor should assume that they will not be allowed to return to their job site until after the storm passes and the base is reopened. Contact ROICC for additional updates and upon completion of required actions.
- e. Condition ONE (Sustained winds of 74 mph or greater expected within 12 hours): If still on the job site, the contractor will be required to immediately leave the base until the storm passes and the base is reopened.

1.6 STORAGE AREAS

The Contract Clause entitled "FAR 52.236-10, Operations and Storage Areas" and the following apply:

1.6.1 Storage Size and Location

The open site available for storage shall be as indicated.

1.7 TEMPORARY SANITARY FACILITIES

Provide adequate sanitary conveniences of a type approved for the use of persons employed on the work, properly secluded from public observation, and maintained in such a manner as required and approved by the Contracting Officer. Maintain these conveniences at all times without nuisance. Upon completion of the work, remove the conveniences from the premises, leaving the premises clean and free from nuisance. Dispose of sewage through connection to a municipal, district, or station sanitary sewage system. Where such systems are not available, use chemical toilets or comparably effective units, and periodically empty wastes into a municipal, district, or station sanitary sewage system, or remove waste to a commercial facility. Include provisions for pest control and elimination of odors.

PART 2 PRODUCTS

2.1 Backflow Preventers

Reduced pressure principle type conforming to the applicable requirements [AWWA C511](#). Provide backflow preventers complete with [150 pound](#) flanged cast iron mounted gate valve and strainer, 304 stainless steel or bronze, internal parts. The particular make, model/design, and size of backflow preventers to be installed shall be included in the latest edition of the List of Approved Backflow Prevention Assemblies issued by the [FCCCHR List](#) and shall be accompanied by a Certificate of Full Approval from [FCCCHR List](#).

PART 3 EXECUTION

3.1 REDUCED PRESSURE BACKFLOW PREVENTERS

Provide an approved reduced pressure backflow prevention assembly at each location where the Contractor taps into the Government potable water supply.

A certified tester(s) shall perform testing of backflow preventer(s) for proper installation and operation and provide subsequent tagging. [Backflow preventer tests](#) shall be performed using test equipment, procedures, and certification forms conforming to those outlined in the latest edition of the Manual of Cross-Connection Control published by the [FCCCHR Manual](#). Test and tag each reduced pressure backflow preventer upon initial installation (prior to continued water use) and quarterly thereafter. Tag shall contain the following information: make, model, serial number, dates of tests, results, maintenance performed, and signature of tester. Record test results on certification forms conforming to requirements cited earlier in this paragraph.

RR1 Repair by Replacement
MCB Camp Lejeune, NC

Project# P1594
27 April 2023

-- End of Section --

SECTION 01 57 19

TEMPORARY ENVIRONMENTAL CONTROLS

07/21

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 the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-461 (2015; Rev G) Requirements for the Control
of Electromagnetic Interference
Characteristics of Subsystems and Equipment

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910 Occupational Safety and Health Standards

40 CFR 261 Identification and Listing of Hazardous
Waste

40 CFR 262 Standards Applicable to Generators of
Hazardous Waste

40 CFR 263 Standards Applicable to Transporters of
Hazardous Waste

40 CFR 264 Standards for Owners and Operators of
Hazardous Waste Treatment, Storage, and
Disposal Facilities

40 CFR 265 Interim Status Standards for Owners and
Operators of Hazardous Waste Treatment,
Storage, and Disposal Facilities

40 CFR 300 National Oil and Hazardous Substances
Pollution Contingency Plan

49 CFR 171 General Information, Regulations, and
Definitions

49 CFR 172 Hazardous Materials Table, Special
Provisions, Hazardous Materials
Communications, Emergency Response
Information, and Training Requirements

49 CFR 178 Specifications for Packagings

1.2 Contractor Liabilities for Environmental Protection

Contractors shall complete and provide [environmental training documentation](#)

for training required by Federal, State, and local regulations.

1.3 DEFINITIONS

1.3.1 Sediment

Soil and other debris that have eroded and have been transported by runoff water or wind.

1.3.2 Solid Waste

Rubbish, debris, garbage, and other discarded solid materials, except recyclables and hazardous waste as defined in paragraph entitled "Hazardous Waste," resulting from industrial, commercial, and agricultural operations and from community activities.

1.3.3 Sanitary Wastes

Wastes characterized as domestic sanitary sewage.

1.3.4 Rubbish

Combustible and noncombustible wastes such as non-recyclable paper and cardboard, crockery, and bones.

Recyclables includes: clean paper, cardboard, glass, plastics (No. 1 & 2), metal, and cans.

Non-recyclable paper and cardboard are defined as material that has become wet or contaminated with food or other residue that render it un-acceptable for recycling.

Treated wood/lumber is defined as wood that has been stained or treated to prevent rot, or composite wood products such as OSB, pressboard furniture, etc.

Untreated wood is defined as lumber, trees, stumps, limbs, tops, and shrubs.

1.3.5 Debris

Combustible and noncombustible wastes such as ashes and waste materials resulting from construction or maintenance and repair work, (excluding organic matter) leaves, pine straw, grass and shrub clippings.

1.3.6 Chemical Wastes

This includes salts, acids, alkalies, herbicides, pesticides, and organic chemicals.

1.3.7 Garbage

Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

1.3.8 Hazardous Waste

Hazardous substances as defined in 40 CFR 261 or as defined by applicable State and local regulations.

1.3.9 Hazardous Materials

Hazardous materials as defined in 49 CFR 171 and listed in 49 CFR 172.

1.3.10 Landscape Features

Trees, plants, shrubs, and ground cover.

1.3.11 Lead Acid Battery Electrolyte

The electrolyte substance (liquid medium) within a battery cell.

1.3.12 Oily Waste

Petroleum products and bituminous materials.

1.3.13 Class I Ozone Depleting Substance (ODS)

Class I and Class II ODS are defined in Sections 602 (a and b) of The Clean Air Act.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00, "Submittal Procedures."

SD-01 Preconstruction Submittals

Environmental protection plan

Preconstruction survey report

SD-06 Test Reports

Abrasive blasting waste materials

Submit a copy of an approved laboratory analysis of materials collected as a result from abrasive blasting operations before disposing of waste materials.

SD-11 Closeout Submittals

Solid waste disposal permit

Disposal permit for hazardous waste

Environmental training documentation

Permit to transport hazardous waste

Hazardous waste certification

Erosion and sediment control inspection reports

Environmental Plan Review

Annual Report of Products Containing Recovered Materials

1.4.1 Solid Waste Disposal Permit

Submit one copy of a State and local permit or license for the solid waste disposal facility.

1.4.2 Disposal Permit for Hazardous Waste

Submit a copy of the applicable EPA and State permits, manifests, or licenses for transportation, treatment, storage, and disposal of hazardous waste by permitted facilities.

1.4.3 Permit to Transport Hazardous Waste

Submit one copy of the EPA or State permit license, or regulation for the transporter who will ship the hazardous waste to the permitted Treatment, Storage, and Disposal (TSD) facility.

1.4.4 Hazardous Waste Certification

Submit written certification that hazardous waste turned in for disposal was generated on Government property and is identified, packaged, and labeled in accordance with 40 CFR 261, 40 CFR 262, and 40 CFR 263.

1.4.5 Erosion and Sediment Control Inspection Reports

Submit to the Contracting Officer once every 7 calendar days and within 24 hours of a storm event that produces 0.5 inch of rain.

1.5 ENVIRONMENTAL PROTECTION REGULATORY REQUIREMENTS

Provide and maintain, during the life of the contract, environmental protection as defined in this Section. Plan for and provide environmental protective measures to control pollution that develops during normal construction practice. Plan for and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary environmental features associated with the project. Comply with Federal, State, and local regulations pertaining to the environment, including but not limited to water, air, solid waste, and noise pollution.

1.6 ENVIRONMENTAL PROTECTION PLAN

1.6.1 Contents of Environmental Protection Plan

- a. Include any hazardous materials (HM) planned for use on the station shall be included in the station HM Tracking Program maintained by the Safety Department. To assist this effort, submit a list (including quantities) of HM to be brought to the station and copies of the corresponding material safety data sheets (MSDS). Submit this list to the Contracting Officer. At project completion, remove any hazardous material brought onto the station. Account for the quantity of HM brought to the station, the quantity used or expended during the job, and the leftover quantity which (1) may have additional useful life as a HM and shall be removed by the Contractor, or (2) may be a hazardous waste, which shall then be removed as specified herein.
- b. The Environmental Protection Plan shall list and quantify any Hazardous Waste (HW) to be generated during the project.

- c. In accordance with station regulations, store HW near the point of generation up to a total quantity of [one quart](#) of hazardous waste or [55 gallons](#) of hazardous waste. Move any volume exceeding these quantities to a HW permitted area within 3 days. Prior to generation of HW, contact Contracting Officer for labeling requirements for storage of hazardous wastes.
- d. In accordance with station regulations, substitute materials as necessary to reduce the generation of HW and include a statement to that effect in the Environmental Plan.
- e. Contact Contracting Officer for conditions in the area of the project which may be subject to special environmental procedures. Include this information in the Preconstruction Survey. Describe in the Environmental Protection Plan any permits required prior to working the area, and contingency plans in case an unexpected environmental condition is discovered.
- f. Obtain permits for handling HW, and deliver completed documents to Contracting Officer for review. File the documents with the appropriate agency, and complete disposal with the approval of Contracting Officer. Deliver correspondence with the State concerning the environmental permits and completed permits to Contracting Officer.

1.6.2 Environmental Protection Plan Format

The Environmental Protection Plan shall follow the following format:

ENVIRONMENTAL PROTECTION PLAN

Contractor Organization
Address and Phone Numbers

- 1. Hazardous materials to be brought onto the station
- 2. MSDS package
- 3. Employee training documentation
- 4. HW storage plan
- 5. HW to be generated
- 6. Preconstruction survey results
- 7. Permitting requirements identified

1.6.3 [Environmental Plan Review](#)

Fourteen days after the environmental protection meeting, submit the proposed environmental plan for further discussion, review, and approval.

1.6.4 [Preconstruction Survey](#)

Perform a preconstruction survey of the project site with the Contracting Officer, and document existing environmental conditions in and adjacent to the site.

1.7 ADMINISTRATIVE REQUIREMENTS

1.7.1 Licenses and Permits

Obtain licenses and permits pursuant to "FAR 52.236-7, Permits and

Responsibilities" except for those permits which will be obtained by the Contracting Officer as follows:

- a. Stormwater Redevelopment Exclusion
- b. Erosion and Sedimentation Control Permit

For permits obtained by the Contracting Officer, whether or not required by the permit, perform inspections of the work in progress, and submit certifications to the applicable regulatory agency, via the Contracting Officer, that the work conforms to the contract and permit requirements. The inspections and certifications shall be provided through the services of a Professional Engineer, registered in the State where the work is being performed. As a part of the quality control plan, which is required to be submitted for approval by the quality control section, provide a subitem containing the name, P.E. registration number, address, and telephone number of the professional engineer(s) who will be performing the inspections and certifications for each permit listed above.

1.8 GENERAL ENVIRONMENTAL MANAGEMENT SYSTEM AND ENVIRONMENTAL AWARENESS

The Contractor shall familiarize himself with requirements of the attached "Marine Corps Base (MCB), Camp Lejeune, Contractor Environmental Guide."

1.9 CAMP LEJEUNE SANITARY LANDFILL INFORMATION

1. Contractors may ONLY use the Camp Lejeune Sanitary Landfill for the disposal of asbestos containing materials, building products with tightly adhered lead containing paint, non-contaminated clean dirt and clean gravel. The hours of operation are 0730-1530.
2. Delivery of acceptable materials (identified above) shall be by appointment only. Appointments made by phone at 910-451-5011 or 910-451-2946. ALL other contractor generated material shall be weighed through the Base Landfill scales before being removed from the Base. Contractors utilizing the base scales will require Contracting Officer assisted pre-registration with the Landfill Manager.
3. The Contracting Officer will register the contract via E-mail, with the Base Landfill. All haul vehicles will maintain a secure vehicle placard as a condition to utilize the scale. E-mail the contract information to the Landfill Clerk, including the name on the Prime Contractor, contract number, job name/description, completion date and whether or not any of the above materials will be delivered to the Landfill.
4. As of May 01 2014 the above supersedes any other statements/specifications pertaining to the delivery of materials to the Base Landfill.

PART 2 PRODUCTS

2.1 ANNUAL REPORT OF PRODUCTS CONTAINING RECOVERED MATERIALS

The Contractor shall submit data annually (by December 1) products used during the previous fiscal year (October 1 - September 30) as required by 6002 of the Solid Waste Disposal Act as amended by Resource Conservation and Recovery Act (RCRA). Report forms is attached to end of this section

as "Appendix A."

PART 3 EXECUTION

3.1 PROTECTION OF NATURAL RESOURCES

Preserve the natural resources within the project boundaries and outside the limits of permanent work. Restore to an equivalent or improved condition upon completion of work. Confine construction activities to within the limits of the work indicated or specified. Conform to the state permitting requirements of the Clean Water Act.

3.1.1 Land Resources

Except in areas to be cleared, do not remove, cut, deface, injure, or destroy trees or shrubs without Contracting Officer's permission. Do not fasten or attach ropes, cables, or guys to existing nearby trees for anchorages unless authorized by Contracting Officer. Where such use of attach ropes, cables, or guys is authorized, the Contractor shall be responsible for any resultant damage.

3.1.1.1 Protection of Trees

Protect existing trees which are to remain and which may be injured, bruised, defaced, or otherwise damaged by construction operations. Remove displaced rocks from uncleared areas. By approved excavation, remove trees with 30 percent or more of their root systems destroyed. Removal of trees and the procedure for removal requires approval of the Contracting Officer.

3.1.1.2 Landscape Replacement

Remove trees and other landscape features scarred or damaged by equipment operations, and replace with equivalent, undamaged trees and landscape features. Obtain Contracting Officer's approval before removal or replacement.

3.1.1.3 Temporary Construction

Remove traces of temporary construction facilities such as haul roads, work area, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other signs of construction. Grade temporary roads, parking areas, and similar temporarily used areas to conform with surrounding contours.

3.1.2 Water Resources

3.1.2.1 Oily Wastes

Prevent oily or other hazardous substances from entering the ground, drainage areas, or local bodies of water. Surround all temporary fuel oil or petroleum storage tanks with a temporary earth berm of sufficient size and strength to contain the contents of the tanks in the event of leakage or spillage.

3.1.3 Fish and Wildlife Resources

Do not disturb fish and wildlife. Do not alter water flows or otherwise significantly disturb the native habitat adjacent to the project and

critical to the survival of fish and wildlife, except as indicated or specified.

3.2 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

Carefully protect in-place and report immediately to the Contracting Officer historical and archaeological items or human skeletal remains discovered in the course of work. Stop work in the immediate area of the discovery until directed by the Contracting Officer to resume work. The Government retains ownership and control over historical and archaeological resources.

3.3 RESTRICTIONS ON EQUIPMENT

3.3.1 Electromagnetic Interference Suppression

- a. Electric motors must comply with MIL-STD-461 relative to radiated and conducted electromagnetic interference. A test for electromagnetic interference will not be required for motors that are identical physically and electrically to those that have previously met the requirements of MIL-STD-461. An electromagnetic interference suppression test will not be required for electric motors without commutation or sliprings having no more than one starting contact and operated at 3,600 revolutions per minute or less.
- b. Equipment used by the Contractor shall comply with MIL-STD-461 for devices capable of producing radiated or conducted interference.
- c. Conduct tests for electromagnetic interference on electric motors and Contractor's construction equipment in accordance with MIL-STD-461. Test location shall be reasonably free from radiated and conducted interference. Furnish testing equipment, instruments, and personnel for making the tests; a test location; and other necessary facilities.

3.3.2 Radio Transmitter Restrictions

Conform to the restrictions and procedures for the use of radio transmitting equipment, as directed. Do not use transmitters without prior approval.

3.4 EROSION AND SEDIMENT CONTROL MEASURES

3.4.1 Burnoff

Burnoff of the ground cover is not permitted.

3.4.2 Borrow Pit Areas

Manage and control borrow pit areas to prevent sediment from entering nearby streams or lakes. Restore areas, including those outside the borrow pit, disturbed by borrow and haul operations. Restoration includes grading, replacement of topsoil, and establishment of a permanent vegetative cover. Uniformly grade side slopes of borrow pit to not more than a slope of 1 part vertical to 2 parts horizontal. Uniformly grade the bottom of the borrow pits to provide a flat bottom and drain by outfall ditches or other suitable means. Stockpile topsoil removed during the borrow pit operation, and use as part of restoring the borrow pit area.

3.4.3 Protection of Erodible Soils

Immediately finish the earthwork brought to a final grade, as indicated or specified. Immediately protect side and back slopes upon completion of rough grading. Plan and conduct earthwork to minimize duration of exposure of unprotected soils.

3.4.4 Temporary Protection of Erodible Soils

Use the following methods to prevent erosion and control sedimentation:

3.4.4.1 Mechanical Retardation and Control of Runoff

Mechanically retard and control the rate of runoff from the construction site. This includes construction of diversion ditches, benches, berms, and use of silt fences and strawbales to retard and divert runoff to protected drainage courses.

3.4.4.2 Sediment Basins

Trap sediment in temporary sediment basins. Pump dry and remove accumulated sediment, after each storm. Use a paved weir or vertical overflow pipe for overflow. Remove collected sediment from the site. Institute effluent quality monitoring programs.

3.4.4.3 Borrow

Permit only in areas where suitable environmental controls are possible.

3.4.4.4 Vegetation and Mulch

Provide temporary protection on sides and back slopes as soon as rough grading is completed or sufficient soil is exposed to require erosion protection. Protect slopes by accelerated growth of permanent vegetation, temporary vegetation, mulching, or netting. Stabilize slopes by hydroseeding, anchoring mulch in place, covering with anchored netting, sodding, or such combination of these and other methods necessary for effective erosion control.

- a. Provide new seeding where ground is disturbed. Include topsoil or nutriment during the seeding operation necessary to establish a suitable stand of grass.

3.5 CONTROL AND DISPOSAL OF SOLID WASTES

Pick up and separate solid wastes, and place in covered containers which are regularly emptied. Do not prepare or cook food on the project site. Prevent contamination of the site or other areas when handling and disposing of wastes. At project completion, leave the areas clean.

3.5.1 Disposal of Metal Paint Cans

All metal paint cans shall be taken to Building 962 for recycling. The cans shall be empty and completely dry. The cans shall be triple rinsed and stenciled "Triple Rinsed" prior to turn in. The Contractor shall give the Government 72 hours advance notice prior to turn-in. Contractor is responsible for rinsing, stenciling, crushing, and depositing in Government owned receptacle, located at Building 962.

3.5.2 Disposal of Rubbish and Debris

Rubbish and debris shall be taken off-base for disposal, unless specifically directed otherwise.

Metals shall be taken to the DRMO disposal area at Lot 203, as specified.

3.5.3 Disposal Off-Base

- a. Provide 24-hour advance written notice to the Contracting Office of Contractor's intention to dispose of off base.
- b. Disposal at sites or landfills not holding a valid State of North Carolina permit is specifically prohibited. The prohibition also applies to sites where a permit may have been applied for but not yet obtained.
- c. Off-base disposal of construction debris outside the parameters of this paragraph at site without State permits and/or not in accordance with regulatory requirements shall require the Contractor at his own expense to remove, transport and relocate the debris to a State approved site. The Contractor shall also be required to pay any fines, penalties, or fees related to the illegal disposal of construction debris

3.6 CONTROL AND DISPOSAL OF HAZARDOUS WASTE

3.6.1 Hazardous Waste Generation

Handle generated hazardous waste in accordance with 40 CFR 262.

3.6.2 Hazardous Waste Disposal

Dispose of hazardous waste in accordance with Federal, State, and local regulations, especially 40 CFR 263, 40 CFR 264, and 40 CFR 265. Removal of hazardous waste from Government property shall not occur without prior notification and coordination with the Contracting officer. Transport hazardous waste by a permitted, licensed, or registered hazardous waste transported to a TSD facility. Hazardous waste shall be properly identified, packaged, and labeled in accordance with 49 CFR 172. Provide completed manifest for hazardous waste disposed of off-site to the Contracting Officer within 7 days of disposal. Hazardous waste shall not be brought onto the station.

3.6.3 Hazardous Waste Storage

Store hazardous waste in containers in accordance with 49 CFR 178. Identify hazardous waste in accordance with 40 CFR 261 and 40 CFR 262. Identify hazardous waste generated within the confines of the station by the station's EPA generator identification number.

3.6.4 Spills of Oil and Hazardous Materials

Take precautions to prevent spills of oil and hazardous material. In the event of a spill, immediately notify the Contracting Officer. Spill response shall be in accordance with 40 CFR 300 and applicable State regulations.

3.6.5 Lead-Acid Batteries

Dispose of lead-acid batteries that are not damaged or leaking at a State-approved battery recycle or at a permitted or interim status hazardous waste TSD facility. For lead-acid batteries that are leaking or have cracked casings, dispose of the electrolyte solution using one of the following alternatives:

- a. An industrial waste water treatment plant, if available and approved by the Contracting Officer for disposing of lead-acid battery electrolyte.
- b. Dispose of the lead-acid battery electrolyte at a permitted or interim status hazardous waste TSD facility.

The management and disposal of waste lead-acid batteries and electrolyte shall comply with requirements for management and disposal of hazardous wastes.

3.6.6 Mercury Control

Prior to starting work, remove thermostats, switches, and other components that contain mercury. Upon removal, place items containing mercury in doubled polyethylene bags, label, and turn over to the Contracting Officer for disposal.

3.6.7 Petroleum Products

Protect against spills and evaporation during fueling and lubrication of equipment and motor vehicles. Dispose of lubricants to be discarded and excess oil.

3.6.8 Ozone Depleting Substances (ODS)

Remove ODS as specified in Section 02 41 00 DEMOLITION.

3.7 DUST CONTROL

Keep dust down at all times, including nonworking periods. Sprinkle or treat, with dust suppressants, the soil at the site, haul roads, and other areas disturbed by operations. Dry power brooming will not be permitted. Instead, use vacuuming, wet mopping, wet sweeping, or wet power brooming. Air blowing will be permitted only for cleaning nonparticulate debris such as steel reinforcing bars. Only wet cutting will be permitted for cutting concrete blocks, concrete, and bituminous concrete. Do not shake bags of cement, concrete mortar, or plaster unnecessarily.

3.7.1 Abrasive Blasting

3.7.1.1 Blasting Operations

The use of silica sand is prohibited in abrasive blasting.

Provide tarpaulin drop cloths and windscreens to enclose abrasive blasting operations to confine and collect dust, abrasive agent, paint chips, and other debris in accordance with the requirements specified. Perform work involving removal of hazardous material in accordance with 29 CFR 1910.

3.7.1.2 Disposal Requirements

Collect dust, abrasive, paint, and other debris resulting from abrasive blasting operations and store in 55 gallon drums with watertight lids. Take a representative sample of this material, and test for EP toxicity with respect to lead, chromium, cadmium content. The sampling and testing shall be performed in accordance with 40 CFR 261.

3.8 QUARANTINE FOR IMPORTED FIRE ANT (4/82)

Onslow, Jones, and Cartaret Counties and portions of Duplin and Craven Counties have been declared a generally infested area by the United States Department of Agriculture (USDA) for the imported fire ant. Compliance with the quarantine regulations established by this authority as set forth in USDA Publication 301.81 of 31 December 1992, is required for operations hereunder. Pertinent requirements of the quarantine for materials originating on the Camp Lejeune reservation, the Marine Corps Air Station (Helicopter), New River and the Marine Corps Air Station, Cherry Point, which are to be transported outside Onslow County or adjacent suppression areas, include the following:

- a. Certification is required for the following articles and they shall not be moved from the reservation to any point outside Onslow County and adjacent designated areas unless accompanied by a valid inspection certificate issued by an Officer of the Plant Protection and Quarantine Program (PPQ) of the U.S. Department of Agriculture.
 - (1) Bulk soil
 - (2) Used mechanized soil-moving equipment. (Used mechanized soil-moving equipment is exempt if cleaned of loose noncompacted soil).
 - (3) Other products, articles, or means of conveyances, if it is determined by an inspector that they present a hazard of transporting spread of the imported fire ant and the person in possession thereof has been so notified.
- b. Authorization for movement of equipment outside the imported fire and regulated area shall be obtained from USDA, Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), Box 28, Goldsboro, North Carolina, 27533-0028, Attn: Mr. William Scroggins or Mr. Frank Best, telephone (919) 735-1941. If Mr. Scroggins or Mr. Best are not available, contact Mr. Jim Kelley at (910) 815-4667, the supervisor's office in Wilmington. Requests for inspection shall be made sufficiently in advance of the date of movement to permit arrangements for the services of authorized inspectors. The equipment shall be prepared and assembled so that it may be readily inspected. Soil on or attached to equipment, supplies, and materials shall be removed by washing with water or such other means as necessary to accomplish complete removal. Resulting spoil shall be wasted as necessary and as directed.

ANNUAL REPORT OF PRODUCTS CONTAINING RECOVERED MATERIALS

Page 1 of 3

Contractor shall submit data annually (By 1 December) for the following products used during the previous fiscal year (1 October - 30 September) as required by 6002 of the Solid Waste Disposal Act as ammended by Resource Conservation and Recovery Act (RCRA):

Contract Number: _____ Fiscal Year: _____

MATERIAL	UNIT	QUANTITY (CRM)	TOTAL QUANTITY
A. <u>Insulation</u>			
1. Loose fill	Ft3		
2. Blanket or batt	Ft2		
3. Board	Ft2		
4. Spray-in-place	m3		
5. Other			
B. <u>Cement and Concrete</u>	yd3		
C. <u>Paper and Paper Products</u>			
1. Copy Paper	Box		
2. Printing/Writing Paper	Box		
3. Corrugated and fiberboard boxes	Box		
4. Folding boxboard and cartons	Box		
5. Stationary, office papers, envelopes, and computer paper	\$Amt		
6. Toilet tissue, paper towels, fasial tissue, paper napkins, doilies and industrial wipes	\$Amt		
7. Brown papers and coarse papers	Box		
8. Other			

APPENDIX A

MATERIAL	DEFINITION
1. Quantity (CRM)	Quantity used containing recovered materials.
2. Total Quantity	Quantity used containing recovered materials plus quantity used not containing recovered materials.
3. Unit	Ft3 (cubic feet), Ft2 (square feet), m3 (cubic meters), yd3 (cubic yards), box (number of boxes used), \$ Amt (dollar value of material used)
4. Loose-Fill Insulation	Includes, but is not limited to..."cellulose fiber, mineral fibers (fiberglass and rock wool), vermiculite, and perlite.
5. Blanket or Batt Insulation	Includes, but is not limited to... "mineral fibers (fiberglass and rock wool)."
6. Board Insulation	This category refers to sheathing, roof decking, and wood panel insulation. It includes, but is not limited to... "cellulose fiber fiberboard, perlite composite board, polyurethane, polyisocyanurate, polystyrene, phenolics, and composites."
7. Spray-in-place Insulation	Includes, but is not limited to... "foam-in-place polyurethane and polyisocyanurate, and spray-on cellulose."
8. Cement or Concrete Containing Recovered Materials, Cement, or Concrete Containing Fly Ash	
9. Copy Paper	This item refers to... "any grade of paper suitable for copying by the xerographic method."
10. Printing & Writing Paper	This item refers to... "paper designed for printing, other than newsprint, such as offset or book paper," and... "paper suitable for pen and ink, pencil, typewriter or printing."

APPENDIX A

MATERIAL	DEFINITION
11. Corrugated & Fiberboard Boxes	Corrugated boxes refer to... "boxes made of corrugated paperboard, which, in turn, is made from a fluted corrugating medium pasted to two flat sheets of paperboard (linerboard)." Fiber or fiberboard boxes refer to... "boxes made from containerboard, either solid fiber or corrugated paperboard (general term); or boxes made from solid paperboard of the same material throughout."
12. Folding Boxes and Cartons	This item refers to... "a paperboard suitable for the manufacture of folding cartons."
13. Stationery, Office Papers, Envelopes, and Manifold Business Forms	This item is considered self-explanatory, however, if questions arise refer to 40 CFR 250.4 for definitions of any of these items.
14. Toilet Tissue, Paper Towels, Facial Tissue, Paper Napkins, Doilies, and Industrial Wipes	This item is considered self-explanatory, however, if questions arise refer to 40 CFR 250.4 for definitions of any of these items.
15. Brown Papers, and Coarse Papers	Brown papers refer to... "papers usually made from unbleached kraft pulp and used for bags, sacks, wrapping paper, and so forth." Coarse papers refer to... "papers used for industrial purposes, as distinguished from those used for cultural or sanitary purposes."
16. Other	Any other type of paper not included in any of the above categories.

APPENDIX A

-- End of Section --

SECTION 01 60 00

REQUIREMENTS FOR PESTICIDE AND HERBICIDE COORDINATION

07/21

PART 1 GENERAL

1.1 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Certificate of North Carolina Licensed Applicator

SD-11 Closeout Submittals

Completed Field Pesticide/Herbicide Management Record Form

1.2 QUALITY ASSURANCE

1.2.1 Certificate of North Carolina Licensed Applicator

A North Carolina licensed applicator is required. Submit a copy of the certificate(s) to the Base Pest Management Coordinator (PMC) through the Contracting Officer.

PART 2 PRODUCTS

2.1 PESTICIDE/HERBICIDE LIST FOR CAMP LEJEUNE

The Contractor shall comply with Base Regulations and use only approved pesticides listed on the current "Approved Pesticide List for Camp Lejeune, NC". The attached document is current as of the date indicated but may be revised at any time. The approved list that is current at the time of application must be utilized. Contact the Contract Officer to obtain the current approved list.

PART 3 EXECUTION

3.1 COORDINATION WITH BASE PEST MANAGEMENT COORDINATOR (PMC)

Contractor shall coordinate with the PMC before proceeding with any pesticide/herbicide application.

3.2 FIELD PESTICIDE/HERBICIDE MANAGEMENT RECORD FORM

Following the pesticide/herbicide application, the Contractor shall complete the attached Field Pesticide/Herbicide Management Record Form and submit to the Base Pest Management Coordinator (PMC) through the Contracting Officer. The completed form(s) shall be submitted within 15 days after application.

-- End of Section --

RR1 Repair by Replacement
MCB Camp Lejeune, NC

Project# P1594
27 April 2023

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
02/19, CHG 3: 11/21

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.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 273	Standards for Universal Waste Management
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 178	Specifications for Packagings

1.2 DEFINITIONS

1.2.1 Co-mingle

The practice of placing unrelated materials together in a single container, usually for benefits of convenience and speed.

1.2.2 Construction Waste

Waste generated by construction activities, such as scrap materials, damaged or spoiled materials, temporary and expendable construction materials, and other waste generated by the workforce during construction activities.

1.2.3 Demolition Debris/Waste

Waste generated from demolition activities, including minor incidental demolition waste materials generated as a result of Intentional dismantling of all or portions of a building, to include clearing of building contents that have been destroyed or damaged.

1.2.4 Disposal

Depositing waste in a solid waste disposal facility, usually a managed landfill or incinerator, regulated in the US under the Resource Conservation and Recovery Act (RCRA).

1.2.5 Diversion

The practice of diverting waste from disposal in a landfill or incinerator, by means of eliminating or minimizing waste, or reuse of materials.

1.2.6 Final Construction Waste Diversion Report

A written assertion by a material recovery facility operator identifying

constituent materials diverted from disposal, usually including summary tabulations of materials, weight in short-ton.

1.2.7 Recycling

The series of activities, including collection, separation, and processing, by which products or other materials are diverted from the solid waste stream for use in the form of raw materials in the manufacture of new products sold or distributed in commerce, or the reuse of such materials as substitutes for goods made of virgin materials, other than fuel.

1.2.8 Reuse

The use of a product or materials again for the same purpose, in its original form or with little enhancement or change.

1.2.9 Salvage

Usable, salable items derived from buildings undergoing demolition or deconstruction, parts from vehicles, machinery, other equipment, or other components.

1.2.10 Source Separation

The practice of administering and implementing a management strategy to identify and segregate unrelated waste at the first opportunity.

1.3 CONSTRUCTION WASTE (INCLUDES DEMOLITION DEBRIS/WASTE)

Divert a minimum of 60 percent by weight of the project construction waste and demolition debris/waste from the landfill or incinerator. Follow applicable industry standards in the management of waste. Apply sound environmental principles in the management of waste. (1) Practice efficient waste management when sizing, cutting, and installing products and materials and (2) use all reasonable means to divert construction waste and demolition debris/waste from landfills and incinerators and to facilitate the recycling or reuse of excess construction materials.

1.4 CONSTRUCTION WASTE MANAGEMENT

Implement a Construction Waste Management Program for the project. Take a pro-active, responsible role in the management of construction construction waste, recycling process, disposal of demolition debris/waste, and require all subcontractors, vendors, and suppliers to participate in the Construction Waste Management Program. Establish a process for clear tracking, and documentation of construction waste and demolition debris/waste.

1.4.1 Implementation of Construction Waste Management Program

Develop and document how the Construction Waste Management Program will be implemented in a Construction Waste Management Plan. Submit a Construction Waste Management Plan to the Contracting Officer for approval. Construction waste and demolition debris/waste materials include un-used construction materials not incorporated in the final work, as well as demolition debris/waste materials from demolition activities or deconstruction activities. In the management of waste, consider the availability of viable markets, the condition of materials, the ability to

provide material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates.

1.4.2 Oversight

The Environmental Manager, as specified in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, is responsible for overseeing and documenting results from executing the Construction Waste Management Plan for the project.

1.4.3 Special Programs

Implement special programs involving rebates or similar incentives related to recycling of construction waste and demolition debris/waste materials. Retain revenue or savings from salvaged or recycling, unless otherwise directed. Ensure firms and facilities used for recycling, reuse, and disposal are permitted for the intended use to the extent required by federal, state, and local regulations.

1.4.4 Special Instructions

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 projects. Designation of single source separating or commingling will be clearly marked on the containers.

1.4.5 Waste Streams

Delineate waste streams and characterization, including estimated material types and quantities of waste, in the Construction Waste Management Plan. Manage all waste streams associated with the project. Typical waste streams are listed below. Include additional waste streams not listed:

- a. Land Clearing Debris
- b. Asphalt
- c. Masonry and CMU
- d. Concrete
- e. Metals (Includes, but is not limited to, banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized, stainless steel, aluminum, copper, zinc, bronze.)
- f. Wood (nails and staples allowed)
- g. Glass
- h. Paper
- i. Plastics (PET, HDPE,PVC,LDPE,PP,PS, Other)
- j. Gypsum
- k. Non-hazardous paint and paint cans
- l. Carpet

- m. Ceiling Tiles
- n. Insulation
- o. Beverage Containers

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Construction Waste Management Plan; G

SD-11 Closeout Submittals

Final Construction Waste Diversion Report; S

1.6 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 Construction Waste Management Plan and to develop a mutual understanding relative to the management of the Construction Waste Management Program and how waste diversion requirements will be met.

The requirements of this meeting may be fulfilled during the coordination and mutual Understanding meeting outlined in Section 01 45 00.00 20 QUALITY CONTROL. At a minimum, discuss and document waste management goals at following meetings:

- a. Preconstruction and Pre-demolition meeting.
- b. Regular Quality Control meetings.
- c. Work safety meeting (if applicable).

1.7 CONSTRUCTION WASTE MANAGEMENT PLAN

Submit Construction Waste Management Plan within 45 calendar days after notice to proceed. Revise and resubmit Construction Waste Management Plan as necessary, in order for construction to begin.. Execute demolition or deconstruction activities in accordance with Section 02 41 00 DEMOLITION. Manage demolition debris/waste or deconstruction materials in accordance with the approved construction waste management plan.

An approved Construction Waste Management Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations or meeting project cumulative waste diversion requirement. Ensure all subcontractors receive a copy of the approved Construction Waste Management Plan. The plan demonstrates how to meet the project waste diversion requirement. Also, include the following in the plan:

- a. Identify the names of individuals responsible for waste management and waste management tracking, along with roles and responsibilities on

the project..

- 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 materials.
- e. Name of landfill and incinerator to be used.
- f. Identification of local and regional re-use programs, including non-profit organizations such as schools, local housing agencies, and organization that accept used materials such as material exchange networks and resale stores. Include the name, location, phone number for each re-use facility identified, and provide a copy of the permit or license for each facility.
- g. List of specific materials, by type and quantity, that will be salvaged for resale, salvaged and reused on the current project, salvaged and stored for reuse on a future project, or recycled. Identify the recycling facilities by name, address, and phone number.
- h. Identification of materials that cannot be recycled or reused with an explanation or justification, to be approved by the Contracting Officer.
- i. Description of the means by which materials identified in item (g) above will be protected from contamination.
- j. 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).
- k. Copy of training plan for subcontractors and other services to prevent contamination by co-mingling materials identified for diversion and waste materials.
- l. Identification of at least 5 construction or demolition material streams for diversion.
- m. Facilities or subcontractors offering construction waste transport on-site or off-site must ensure that proper shipping orders, bill of lading, manifests, or other shipping documents containing waste diversion information meet requirements of 40 CFR 273 Universal Waste Management, 49 CFR 173 Shippers - General Requirements for Shipments and Packagings, and 49 CFR 178 Specifications for Packaging. Individuals signing manifests or other shipping documents should meet the minimum training requirements.
- n. List each supplier who deliver construction materials, in bulk, or package products in returnable containers or returnable packaging, or have take-back programs. List each program and the applicable material to actively monitor and track to assist in meeting waste

diversion requirements on the project.

Distribute copies of the waste management plan to each subcontractor, [Environmental Manager](#), and the Contracting Officer.

1.8 RECORDS (DOCUMENTATION)

1.8.1 General

Maintain records to document the types and quantities of waste generated and diverted through re-use, recycling and sale to third parties; through disposal to a landfill or incinerator facility. Provide explanations for materials not recycled, reused or sold. Collect and retain manifests, weight tickets, sales receipts, and invoices specifically identifying diverted project waste materials or disposed materials.

1.8.2 Accumulated

Maintain a running record of materials generated and diverted from landfill disposal, including accumulated diversion rates for the project. Make records available to the Contracting Officer during construction or incidental demolition activities. Provide a copy of the diversion records to the Contracting Officer upon completion of the construction, incidental demolitions or minor deconstruction activities.

1.9 FINAL CONSTRUCTION WASTE DIVERSION REPORT

A Final Construction Waste Diversion Report is required at the end of the project. Provide [Final Construction Waste Diversion Report](#) 60 days prior to the Beneficial Occupancy Date (BOD). The final Construction Waste Diversion Report must be included in the Sustainability eNotebook in accordance with Section [01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING](#).

1.10 COLLECTION

Collect, store, protect, and handle reusable and recyclable materials at the site in a manner which prevents contamination, and provides protection from the elements to preserve their usefulness and monetary value. Provide receptacles and storage areas designated specifically for recyclable and reusable materials and label them clearly and appropriately to prevent contamination from other waste materials. Keep receptacles or storage areas neat and clean.

Train subcontractors and other service providers to either separate waste streams or use the co-mingling method as described in the Construction Waste Management Plan. Handle hazardous waste and hazardous materials in accordance with applicable regulations and coordinate with Section [01 57 19 TEMPORARY ENVIRONMENTAL CONTROL](#). Separate materials by one of the following methods described herein:

1.10.1 Source Separation Method

Separate waste products and materials that are recyclable from trash and sort as described below into appropriately marked separate containers and then transport 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 category types as defined in the Construction Waste Management Plan.

1.10.2 Other Methods

Other methods proposed by the Contractor may be used when approved by the Contracting Officer.

1.11 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 as described in the waste management plan. Except as otherwise specified in other sections of the specifications, dispose of in accordance with the following:

1.11.1 Reuse

Give first consideration to reusing construction and demolition materials as a disposition strategy. Recover for reuse materials, products, and components as described in the approved Construction Waste Management Plan. Coordinate with the Contracting Officer to identify onsite reuse opportunities or material sales or donation available through Government resale or donation programs. Sale of recovered materials is not allowed on the Installation. Consider the use of surplus industrial supply broker services, who match entities with reusable or repurpose industrial materials with entities with need of such materials.

1.11.2 Recycle

Recycle non-hazardous construction and demolition/debris materials that are not suitable for reuse. Track rejection of contaminated recyclable materials by the recycling facility. Rejected recyclables materials will not be counted as a percentage of diversion calculation. Recycle all fluorescent lamps, HID lamps, mercury (Hg) -containing thermostats and ampoules, and PCBs-containing ballasts and electrical components as directed by the Contracting Officer. Do not crush lamps on site as this creates a hazardous waste stream with additional handling requirements.

1.11.3 Waste

Dispose by landfill or incineration only those waste materials with no practical use, economic benefit, or recycling opportunity.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used. -- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 78 00

CLOSEOUT PROCEDURES

07/21

PART 1 GENERAL

1.1 SUBMITTALS

Submit the following in accordance with Section 01 33 00, "Submittal Procedures."

SD-10, Operation and Maintenance Data

Equipment/product warranty list

Submit Data Package 1 in accordance with Section 01 78 23, "Operation and Maintenance Data."

SD-11 Closeout Submittals

As-built drawings

Record of materials

Maximo requirements

Complete Submittal Package 2 CD/DVD's

Equipment/product warranty tag

1.2 PROJECT RECORD DOCUMENTS

As-Built Drawings will be submitted as specified in 1.2.1 along with GIS Deliverables which will be created and submitted as specified in Section 01 78 30.00 22 GIS DATA DELIVERABLES.

1.2.1 As-Built Drawings

"FAC 5252.236-9310, Record Drawings." As-built drawings will be submitted in redline mark-up format.

1.2.2 As-Built Record of Materials

Furnish a record of materials.

Where several manufacturers' brands, types, or classes of the item listed have been used in the project, designate specific areas where each item was used. Designations shall be keyed to the areas and spaces depicted on the contract drawing. Furnish the record of materials used in the following format:

MATERIALS DESIGNATION	SPECIFICATION	MANUFACTURER	MATERIALS USED (MANUFACTURER'S DESIGNATION)	WHERE USED
--------------------------	---------------	--------------	---	---------------

1.3 MAXIMO REQUIREMENTS

Submit maximo requirements as specified in Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS.

1.4 EQUIPMENT/PRODUCT WARRANTIES

1.4.1 Equipment/Product Warranty List

Furnish to the Contracting Officer a bound and indexed notebook containing written warranties for equipment/products that have extended warranties (warranty periods exceeding the standard one-year warranty) furnished under the contract, and prepare a complete listing of such equipment/products. The equipment/products list shall state the specification section applicable to the equipment/product, duration of the warranty therefor, start date of the warranty, ending date of the warranty, and the point of contact for fulfillment of the warranty. The warranty period shall begin on the same date as project acceptance and shall continue for the full product warranty period. Execute the full list and deliver to the Contracting Officer prior to final acceptance of the facility.

1.4.2 Equipment Warranty Tags and Guarantor's Local Representative

Furnish with each warranty the name, address, and telephone number of the guarantor's representative nearest to the location where the equipment and appliances are installed. The guarantor's representative, upon request of the station representative, shall honor the warranty during the warranty period, and shall provide the services prescribed by the terms of the warranty. At the time of installation, tag each item of warranted equipment with a durable, oil- and water-resistant tag approved by the Contracting Officer. Attach tag with copper wire and spray with a clear silicone waterproof coating. Leave the date of acceptance and QC's signature blank until project is accepted for beneficial occupancy. Tag shall show the following information:

EQUIPMENT/PRODUCT WARRANTY TAG

Type of Equipment/Product _____
Warranty Period _____ From _____ To _____
Contract No. _____
Inspector's Signature _____ Date Accepted _____

Construction Contractor:

Name: _____
Address: _____
Telephone: _____

Warranty Contact: _____

Name: _____
Address: _____
Telephone: _____

STATION PERSONNEL TO PERFORM ONLY OPERATIONAL MAINTENANCE

1.5 MECHANICAL TESTING AND BALANCING

All contract requirements of Section 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC shall be fully completed, including all testing, prior to contract completion date. In addition, all contract requirements of Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC shall be fully completed, including testing and inspection, prior to contract completion date, except as noted otherwise in Section 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC. The time required to complete all work and testing as prescribed by Section 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC is included in the allotted calendar days for completion.

1.6 COMPLETE SUBMITTAL PACKAGE

Contractor shall make electronic copies of all submittals, including the approved transmittal sheets, and provide two (2) CD/DVD's containing all submittals for the project.

The CD/DVD's shall be marked "Complete Submittal Package - Contract #_____. "

1.7 CLEANUP

Leave premises "broom clean." Clean interior and exterior glass surfaces exposed to view; remove temporary labels, stains and foreign substances; polish transparent and glossy surfaces; vacuum carpeted and soft surfaces. Clean equipment and fixtures to a sanitary condition. Clean filters of operating equipment. Clean debris from roofs, gutters, downspouts and drainage systems. Sweep paved areas and rake clean landscaped areas. Remove waste and surplus materials, rubbish and construction facilities from the site.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

07/21

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.

ASTM INTERNATIONAL (ASTM)

ASTM E1971

(2005; R 2011) Standard Guide for
Stewardship for the Cleaning of Commercial
and Institutional Buildings

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-10 Operation and Maintenance Data

O&M Database

Training Plan

Training Outline

Training Content

SD-11 Closeout Submittals

Training Video Recording

Validation of Training Completion

1.3 OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data for the provided equipment, product, or system, defining the importance of system interactions, troubleshooting, and long-term preventive operation and maintenance. Compile, prepare, and aggregate O&M data to include 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.

1.3.1 Package Quality

Documents must be fully legible. Operation and Maintenance data must be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions.

1.3.2 Package Content

Provide data package content in accordance with paragraph 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. Use Data Package 3 for commissioned items without a specified data package requirement in the individual technical sections. Provide a Data Package 3 instead of Data Package 1 or 2, as specified in the individual technical section, for items that are commissioned.

1.3.3 Changes to Submittals

Provide manufacturer-originated changes or revisions to submitted data if a component of an item is so affected subsequent to acceptance of the O&M Data. Submit changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data within 30 calendar days of the notification of this change requirement.

1.4 O&M DATABASE

Develop an editable, electronic spreadsheet based on the equipment in the Operation and Maintenance Manuals that contains the information required to start a preventive maintenance program. As a minimum, provide list of system equipment, location installed, warranty expiration date, manufacturer, model, and serial number.

1.5 OPERATION AND MAINTENANCE MANUAL FILE FORMAT

Assemble data packages into electronic Operation and Maintenance Manuals. Assemble each manual into a composite electronically indexed file using the most current version of Adobe Acrobat or similar software capable of producing PDF file format. Provide compact disks (CD) or data digital versatile disk (DVD) as appropriate, so that each one contains operation, maintenance and record files, project record documents, and training videos. Include a complete electronically linked operation and maintenance directory.

1.5.1 Organization

Bookmark Product and Drawing Information documents using the current version of CSI Masterformat numbering system, and arrange submittals using the specification sections as a structure. Use CSI Masterformat and UFGS numbers along with descriptive bookmarked titles that explain the content of the information that is being bookmarked.

1.5.2 CD or DVD Label and Disk Holder or Case

Provide the following information on the disk label and disk holder or case:

- a. Building Number
- b. Project Title
- c. Activity and Location
- d. Construction Contract Number

- e. Prepared For: (Contracting Agency)
- f. Prepared By: (Name, title, phone number and email address)
- g. Include the disk content on the disk label
- h. Date
- i. Virus scanning program used

1.6 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES

The following are a detailed description of the data package items listed in paragraph SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES.

1.6.1 Operating Instructions

Provide specific instructions, procedures, and illustrations for the following phases of operation for the installed model and features of each system:

1.6.1.1 Safety Precautions and Hazards

List personnel hazards and equipment or product safety precautions for operating conditions. List all residual hazards identified in the Activity Hazard Analysis provided under Section 01 35 29 SAFETY AND OCCUPATIONAL HEALTH REQUIREMENTS. Provide recommended safeguards for each identified hazard.

1.6.1.2 Operator Prestart

Provide procedures required to install, set up, and prepare each system for use.

1.6.1.3 Startup, Shutdown, and Post-Shutdown Procedures

Provide narrative description for Startup, Shutdown and Post-shutdown operating procedures including the control sequence for each procedure.

1.6.1.4 Normal Operations

Provide Control Diagrams with data to explain operation and control of systems and specific equipment. Provide narrative description of Normal Operating Procedures.

1.6.1.5 Emergency Operations

Provide 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. Provide Emergency Shutdown Instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance and procedures for emergency operation of utility systems including required valve positions, valve locations and zones or portions of systems controlled.

1.6.1.6 Operator Service Requirements

Provide instructions for services to be performed by the operator such as

lubrication, adjustment, inspection, and recording gauge readings.

1.6.1.7 Environmental Conditions

Provide 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.

1.6.1.8 Operating Log

Provide forms, sample logs, and instructions for maintaining necessary operating records.

1.6.1.9 Additional Requirements for HVAC Control Systems

Provide Data Package 5 and the following for control systems:

- a. Narrative description on how to perform and apply 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 checkout tests and calibrations performed by the Contractor (not Cx tests).
- d. Full points list. Provide a listing of rooms 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 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. Marking of system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

1.6.2 Preventive Maintenance

Provide the following information for preventive and scheduled maintenance to minimize repairs for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials.

1.6.2.1 Lubrication Data

Include the following preventive maintenance lubrication data, in addition to instructions for lubrication required under paragraph 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.

1.6.2.2 Preventive Maintenance Plan, Schedule, and Procedures

Provide manufacturer's schedule for routine preventive maintenance, inspections, condition monitoring (predictive tests) and adjustments required to ensure proper and economical operation and to minimize repairs. Provide instructions stating when the systems should be retested. 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.

- a. Define the anticipated time required to perform each of each test (work-hours), test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements within the schedule. Provide a remarks column for the testing validation procedure referencing operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Delineate procedures for preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize repairs.
- b. Repair requirements must inform operators how to check out, troubleshoot, repair, and replace components of the system. Include electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting of the system after acceptance.

1.6.2.3 Cleaning Recommendations

Provide environmentally preferable cleaning recommendations in accordance with ASTM E1971.

1.6.3 Repair

Provide manufacturer's recommended procedures and instructions for correcting problems and making repairs for the installed model and

features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials.

1.6.3.1 Troubleshooting Guides and Diagnostic Techniques

Provide 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.

1.6.3.2 Wiring Diagrams and Control Diagrams

Provide 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.

1.6.3.3 Repair Procedures

Provide instructions and a list of tools required to repair or restore the product or equipment to proper condition or operating standards.

1.6.3.4 Removal and Replacement Instructions

Provide step-by-step procedures and a list of required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Use a combination of text and illustrations.

1.6.3.5 Spare Parts and Supply Lists

Provide lists of spare parts and supplies required for 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.

1.6.3.6 Repair Work-Hours

Provide manufacturer's projection of repair work-hours including requirements by type of craft. Identify, and tabulate separately, repair that requires the equipment manufacturer to complete or to participate.

1.6.4 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:

1.6.4.1 Product Submittal Data

Provide a copy of SD-03 Product Data submittals documented with the required approval.

1.6.4.2 Manufacturer's Instructions

Provide a copy of SD-08 Manufacturer's Instructions submittals documented with the required approval.

1.6.4.3 O&M Submittal Data

Provide a copy of SD-10 Operation and Maintenance Data submittals documented with the required approval.

1.6.4.4 Parts Identification

Provide identification and coverage for the 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 must show the index, reference, or key number that will cross-reference the illustrated part to the listed part. Group the parts shown in the listings 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.

1.6.4.5 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 of the system. Provide copies of warranties required by Section 01 78 00 CLOSEOUT SUBMITTALS.

1.6.4.6 Extended Warranty Information

List all warranties for products, equipment, components, and sub-components whose duration exceeds one year. For each warranty listed, indicate the applicable specification section, duration, start date, end date, and the point of contact for warranty fulfillment. Also, list or reference the specific operation and maintenance procedures that must be performed to keep the warranty valid. Provide copies of warranties required by Section 01 78 00 CLOSEOUT SUBMITTALS.

1.6.4.7 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.

1.6.4.8 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. Provide final set points.

1.6.4.9 Testing and Performance Data

Include completed prefunctional checklists, functional performance test forms, and monitoring reports. Include recommended schedule for retesting and blank test forms. Provide final set points.

1.6.4.10 Field Test Reports

Provide a copy of Field Test Reports (SD-06) submittals documented with the required approval.

1.6.4.11 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.

1.7 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

Provide the O&M data packages specified in individual technical sections. The information required in each type of data package follows:

1.7.1 Data Package 1

- a. Safety precautions and hazards
- b. Cleaning recommendations
- c. Maintenance and repair procedures
- d. Warranty information
- e. Extended warranty information
- f. Contractor information
- g. Spare parts and supply list

1.7.2 Data Package 2

- a. Safety precautions and hazards
- b. Normal operations
- c. Environmental conditions
- d. Lubrication data
- e. Preventive maintenance plan, schedule, and procedures
- 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. Extended warranty information
- m. Contractor information

1.7.3 Data Package 3

- a. Safety precautions and hazards
- b. Operator prestart
- c. Startup, shutdown, and post-shutdown procedures
- d. Normal operations
- e. Emergency operations
- f. Environmental conditions
- g. Operating log
- h. Lubrication data
- i. Preventive maintenance plan, schedule, and procedures
- 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. Product submittal data
- q. O&M submittal data
- r. Parts identification
- s. Warranty information
- t. Extended warranty information
- u. Testing equipment and special tool information
- v. Testing and performance data
- w. Contractor information

- x. Field test reports

1.7.4 Data Package 4

- a. Safety precautions and hazards
- b. Operator prestart
- c. Startup, shutdown, and post-shutdown procedures
- d. Normal operations
- e. Emergency operations
- f. Operator service requirements
- g. Environmental conditions
- h. Operating log
- i. Lubrication data
- j. Preventive maintenance plan, schedule, and procedures
- k. Cleaning recommendations
- l. Troubleshooting guides and diagnostic techniques
- m. Wiring diagrams and control diagrams
- n. Repair procedures
- o. Removal and replacement instructions
- p. Spare parts and supply list
- q. Repair work-hours
- r. Product submittal data
- s. O&M submittal data
- t. Parts identification
- u. Warranty information
- v. Extended warranty information
- w. Personnel training requirements
- x. Testing equipment and special tool information
- y. Testing and performance data
- z. Contractor information
- aa. Field test reports

1.7.5 Data Package 5

- a. Safety precautions and hazards
- b. Operator prestart
- c. Start-up, shutdown, and post-shutdown procedures
- d. Normal operations
- e. Environmental conditions
- f. Preventive maintenance plan, schedule, and procedures
- 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. Extended warranty information
- s. Testing and performance data
- t. Contractor information
- u. Field test reports
- v. Additional requirements for HVAC control systems

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 TRAINING

Prior to acceptance of the facility by the Contracting Officer for Beneficial Occupancy, provide comprehensive training for the systems and equipment specified in the technical specifications. The training must be targeted for the building maintenance personnel, and applicable building occupants. Instructors must be well-versed in the particular systems that

they are presenting. Address aspects of the Operation and Maintenance Manual submitted in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS. Training must include classroom or field lectures based on the system operating requirements. The location of classroom training requires approval by the Contracting Officer.

3.1.1 Training Plan

Submit a written training plan to the Contracting Officer for approval at least 60 calendar days prior to the scheduled training. Training plan must be approved by the Quality Control Manager (QC) prior to forwarding to the Contracting Officer. Also, coordinate the training schedule with the Contracting Officer and QC. Include within the plan the following elements:

- a. Equipment included in training
- b. Intended audience
- c. Location of training
- d. Dates of training
- e. Objectives
- f. Outline of the information to be presented and subjects covered including description
- g. Start and finish times and duration of training on each subject
- h. Methods (e.g. classroom lecture, video, site walk-through, actual operational demonstrations, written handouts)
- i. Instructor names and instructor qualifications for each subject
- j. List of texts and other materials to be furnished by the Contractor that are required to support training
- k. Description of proposed software to be used for video recording of training sessions.

3.1.2 Training Content

The core of this training must be based on manufacturer's recommendations and the operation and maintenance information. The QC is responsible for overseeing and approving the content and adequacy of the training. Spend 95 percent of the instruction time during the presentation on the OPERATION AND MAINTENANCE DATA. Include the following for each system training presentation:

- a. Start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up and programming, troubleshooting, and alarms.
- b. Relevant health and safety issues.
- c. Discussion of how the feature or system is environmentally responsive. Advise adjustments and optimizing methods for energy conservation.

- d. Design intent.
- e. Use of O&M Manual Files.
- f. Review of control drawings and schematics.
- g. Interactions with other systems.
- h. Special maintenance and replacement sources.
- i. Tenant interaction issues.

3.1.3 Training Outline

Provide the Operation and Maintenance Manual Files (Bookmarked PDF) and a written course outline listing the major and minor topics to be discussed by the instructor on each day of the course to each trainee in the course. Provide the course outline 14 calendar days prior to the training.

3.1.4 Training Video Recording

Record classroom training session(s) on video. Provide to the Contracting Officer two copies of the training session(s) in DVD video recording format. Capture within the recording, in video and audio, the instructors' training presentations including question and answer periods with the attendees. The recording camera(s) must be attended by a person during the recording sessions to assure proper size of exhibits and projections during the recording are visible and readable when viewed as training.

3.1.5 Unresolved Questions from Attendees

If, at the end of the training course, there are questions from attendees that remain unresolved, the instructor must send the answers, in writing, to the Contracting Officer for transmittal to the attendees, and the training video must be modified to include the appropriate clarifications.

3.1.6 Validation of Training Completion

Ensure that each attendee at each training session signs a class roster daily to confirm Government participation in the training. At the completion of training, submit a signed validation letter that includes a sample record of training for reporting what systems were included in the training, who provided the training, when and where the training was performed, and copies of the signed class rosters. Provide two copies of the validation to the Contracting Officer, and one copy to the Operation and Maintenance Manual Preparer for inclusion into the Manual's documentation.

3.1.7 Quality Control Coordination

Coordinate this training with the QC in accordance with 01 45 00.00 20
QUALITY CONTROL.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 78 30.00 22

GIS DATA DELIVERABLES

07/21

PART 1 GENERAL

1.1 OBJECTIVE

The primary objective of this section is to provide detailed specifications for collection and delivery of geospatial data commonly referred to as Geographic Information System (GIS) data. Additionally, this section shall provide guidance to ensure that all GIS data delivered is compatible and will add value to the.

Failure to comply with the specifications outlined in this document will result in non-acceptance of data deliverables.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-11 Closeout Submittals

GIS Data Deliverables; G

1.3 GOVERNMENT GEOSPATIAL DATA AND SCHEMA

1. The IGI&S repository model schema is based on the Spatial Data Standards for Facilities, Infrastructure and Environment (SDSFIE) GEOFidelis Data Model with recurring business driven modifications and or adaptations.
 - a. Data will be created and delivered by developing an ARCGIS Personal GEODatabase using ArcGIS 10.1 or higher if a higher version is being utilized by the Government at the time the deliverable is being developed.
 - b. Request the existing GIS Data, Schema and Domain Properties by means of a Data Request Package (DRP). Receipt of request will include Geospatial Database table structure, schema, Domain configuration, Attribute text format, i.e., case size as well as Meta Data information.
 - c. The DRP should be submitted prior to the start of data collection efforts and again every 6 months for the duration of the contract. Ensure that all GIS data has been created and delivered utilizing the most up to date IGI&S GEODatabase schema.
 - d. Verify the ArcGIS and schema version, via the CM or PM, at the commencement of this contract. All GIS DATA DELIVERABLES will be created in accordance with the current version and these specifications.

2. Submit a request for a Geospatial DRP to the CM or the Project Manager.
 - a. Request to be completely filled out and include all the information as instructed on the data request form.
 - b. Request only GIS data and or schema for feature classes that are relevant to the contract and within the boundary of project area.
 - c. Attach Scope of Work, which is defined by this GIS DATA DELIVERABLES section for each project request.
 - d. Return the DRP to the CM or Project Manager for sponsorship and submittal to the Installation Geospatial Information & Services (IGI&S) Office.
 - e. Incomplete forms may delay receipt of the requested GIS data and Schema.

1.3.1 Global Positioning System (GPS) and Spatial Reference Properties

GPS data shall be completed in accordance with the GPS Data Collection and Documentation Standards, Version 4 (or higher version if available at the time of this project) as prepared by Geographic Information Coordinating Council (GICC) Statewide Mapping Advisory Committee (SMAC) and adopted by the [North Carolina](#) Geographic Information Coordinating Council.

1. Prior to GPS efforts, ALL underground utilities are to be located utilizing a utility locating service in order to verify and obtain accurate feature locations.
2. Only bench marks included in the [North Carolina](#) Geodetic Survey Base Station Network are to be used for GPS data collection.
3. Mission planning is essential. Utilize the best Position Dilution of Precision (PDOP) values for data accuracy.
4. Utility data, as identified in paragraph "ATTRIBUTE DATA COLLECTION AND GPS REQUIREMENTS FOR SPECIFIC FEATURES" will be collected utilizing Survey Grade GPS data collection methods.
5. Infrastructure data, as identified in paragraph "ATTRIBUTE DATA COLLECTION AND GPS REQUIREMENTS FOR SPECIFIC FEATURES" will be collected utilizing Sub-Foot or better GPS data collection methods.
 - a. Spatial accuracy requirements for Survey and Sub-Foot grade data collection are as follows:
 - i. Sub-Foot requirements:
 - 1) All points shall be within + 12 inches
 - 2) 95 percent accuracy rate for all points.
 - ii. Survey Grade requirements:
 - 1) All points shall be within + 1 centimeter
 - 2) 98 percent accuracy rate for all points

6. Make every effort to capture feature locations without using offsets. All Offsets will be noted in the Final Report for each feature.
7. Excessive offsets included in the Final Data, which will be referenced in the Final Report, will be reviewed for quality control.
 - a. Resubmittal of data will be required if PDOP planning was not observed per this specification.

1.3.2 Demolished and Abandoned in Place (AIP) Features

Reference all Demolished and or AIP features in the data delivered. Should the current feature data class attributes and or domains not reference AIP or demolished features, the Contractor will be responsible for appropriately delivering these features by creating an associated "Demolished" or AIP feature class for all point and polyline data, i.e., CLJN.CL.WastewaterUtilitySegment and CLJN.CL.WateUtilNode_wHydrant, etc.

1. Utilize a blank schema for the associated feature class.
2. Rename associated feature class and add DEMO or AIP as a prefix, i.e., DEMO.CLJN.CL.WastewaterUtilitySegment, AIP.CLJN.CL.WastewaterUtilitySegment.
3. All demolished and or AIP features should provide existing spatial and non-spatial data which may be copied from existing data.
4. Update attributes appropriately to include the following:
 - a. Contract Number.
 - b. Drawing Number.
 - c. isDemolished.
 - d. dateDemolished or dateAIP.
 - e. Status.

1.3.3 Creating a New Feature Class

Should a new feature class be required that is not readily available in the current GIS schema provided by the Government. Contact the CM or Project Manager for guidance and schema format.

1.3.4 GIS Topology Rules

All data must be created using GIS topology rules for polygons, points and lines, such as, but not limited to the following examples:

1. Polygons, Polylines and points rules; please reference illustrating topology rules in ArcGIS at www.esri.com.
2. Polygons must not have slivers.
3. All utility or infrastructure system data, which is, but is not limited to, transportation system and electrical, water, steam distribution, and wastewater collection, etc., will be created using GIS spatial connectivity rules which specify that vertex, edge and

endpoints be snapped to features within the system.

4. Features will be snapped to the appropriate item.
5. Data will be created to represent the real world, for example, water, sewer, and transportation systems, etc. will be drawn and or created in the direction of flow.
6. Utility and transportation systems will be created from source to sink, etc.
7. Abandoned In Place (AIP) utility lines will be located and updated in the current feature data set and identified as AIP in the attribute table or provide in a feature data set as specified in paragraph "Demolished and Abandoned in Place (AIP) Features" with CM approval.

1.3.5 Creation of Geographic Data Documentation (METADATA)

For each digital file delivered containing geographic information, provide documentation consistent with the Federal Geographic Data Committee (FGDC) Content Standards for Digital Geospatial Metadata (CSDGM).

Metadata generation tools included in the ArcGIS suite of software (or equivalent technology) will be used in the production of the required metadata in XML format. Regardless of the tools used for metadata creation, must ensure that the metadata is delivered in XML format and can be easily imported into the IGI&S GEODatabase.

(NOTE: The metadata should be formatted from the Government perspective, not the Contractor project perspective. Therefore such items as Point of Contact (POC) should be the POC currently associated with the data and NOT the Contractor's Project Manager. Use language and format consistent with existing metadata.)

1.3.6 GIS Submittals Guidelines

All GIS Submittals will be submitted to the CM or PM and then analyzed by Government GIS personnel prior to final approval. Failure to comply with the specifications outlined in this document will result in non-acceptance of data deliverables.

1. Prior to any database development, provide the Government with a technical approach document, in PDF format, for review and approval. The Technical Approach document will describe in detail the Contractor's technical approach to designing and developing the database.
2. All attributes will be populated in accordance with the "ATTRIBUTE DATA COLLECTION AND GPS REQUIREMENTS FOR SPECIFIC FEATURES" and will be obtained via contract specifications, plans and record drawings.
3. Research may be required to be conducted to collect data and make copies of reports and studies as necessary to verify existing and/or record drawing data. Record drawing data and closed contracts can be located in the Technical Records Section in the Public Works Department which is located at .
4. Raw GPS data and collection data files will be included with every phase of delivery.

5. Actual spatial and non-spatial conditions in the field always supersede drawings. Locate and field verify all features to ensure attribute data and location is correctly recorded.
6. Submit a preliminary review of data at 25 percent contract completion to ensure specifications compliance.
7. Deliver digital geographic maps, GPS collection files and related data. All working text and documents and personal geodatabase will be included for review in the draft and final delivery of data.
 - a. All maps of **GIS DATA DELIVERABLES** will be ANSI C size and include a project title, contract number, scale, legend, standard symbology, attributes, i.e., building numbers, road names, segment diameters, etc. Also provide a PDF copy of all maps.
8. When required, provide a technical consultant to meet on site.
9. Do not deliver blank unused schema or feature class data with no attributes. Deliver only data pertinent to the contract that adds value to the GEODatabase per this section.
10. When projects are constructed in phases, deliver GIS Data at the end of each phase for all Phased Projects and Construction projects.
11. It is the Contractor's responsibility to perform quality assurance for all data and related materials required in the section prior to submitting product to the Government.
12. The data will be analyzed for discrepancies in subject content, correct format in accordance with this statement of work, and compatibility with the existing GIS system as well as all other specifications in this section.

1.3.7 Formats, Versions and Guidelines

All data deliverables will be in the following formats and/or versions.

1. GIS data will be provided in an ArcGIS 10.1 or higher if a higher version is being used by the Government at the time of this project. Verify the ArcGIS version, via the CM or PM at the commencement of this contract.
2. Microsoft Windows 7 operating system, unless otherwise approved by the Government.
3. All reports and maps will be delivered as a hard copy and in a searchable Adobe Portable Document Format (PDF).
4. All text, spreadsheet, database files, reports, and maps will be delivered on Digital Versatile Disc read - only memory (DVD-ROM).
5. Verify required version(s) of software and schema, via the CM or PM.
6. Map submittals will accompany each geospatial deliverable.
 - a. Include ANSI C map for each project/area.

- b. Data should be labeled and attributed per specification.
- c. All maps should include the date, a legend, scale, contract title, and number.
- d. Each map should be exported on a .pdf and delivered electronically with the project.

1.3.8 Final Report Requirements with additional Guidelines

Follow the following:

1. Specific procedures and list of equipment, software and versions that were utilized for the GPS data collection and creation of geospatial data.
2. Submit all GPS data files.
3. Provide the date(s) the IGI&S schema and geospatial data was received.
4. Provide details on any offsets to include justification as to why offsets were utilized and on which features and or points offsets were used.
5. Describe all modifications to the geodatabase to include the name of all new features classes, i.e., new, demolished or AIP.
6. Provide the source that was utilized for required attributes.
 - a. Include an ANSI C size copy of all design drawings that were referenced in the attribute data. This information should be included in all phases of delivery to include draft and final reviews.
 - b. Provide the overall utility site plan drawing(s) with each submittal.
 - c. Provide a separate map for communication which includes infrastructure in PDF format.
7. Specify Deliverable "Draft #" or "Final Submittal" when data is submitted to the CM or PM for review.
8. Provide the name and contact information for the GIS Technical Point of Contact who can answer questions regarding the data deliverable.
9. GIS DATA DELIVERABLES must be provided in a format that does not require translation or pre/post processing prior to being loaded into the IGI&S GEODatabase.
10. Provide any miscellaneous information that is deemed significant.
11. Provide the current version of the GIS DATA DELIVERABLES specification utilized for this contract submittal.

1.3.9 Ownership

All digital files, final hardcopy products, GPS raw data, source data acquired for this project, and related materials, including that furnished

by the Government, will become the property of the Government and will not be issued, posted, distributed, or published by the Contractor. All documentation will be delivered in the final delivery.

Note: No endorsement of software or hardware is implied.

1.4 ATTRIBUTE DATA COLLECTION AND GPS REQUIREMENTS FOR SPECIFIC FEATURES

1.4.1 Non-Compliance

Failure to follow the specification outlined in this document will result in non-acceptance of data deliverable.

Note: Geospatial data delivery does not replace record drawing requirements.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 91 00.15 20

TOTAL BUILDING COMMISSIONING
02/21, CHG 1: 05/21

PART 1 GENERAL

Total Building Commissioning (TBCx) is a systematic, quality-focused process for enhancing the delivery of a project that focuses on verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the project requirements. The purpose is to reduce the cost and performance risks associated with delivering facilities projects, and to increase value to owners, occupants, and users.

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 HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

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)

ANSI/SMACNA 014 (2013) HVAC Systems Commissioning Manual,
2nd Edition

1.2 DEFINITIONS

Commissioning Process (Cx) - a quality-focused process for enhancing the delivery of a project. Refer to **ASHRAE 202** for a comprehensive description of the commissioning process.

Commissioning Provider (CxP) - The entity who leads, plans, and coordinates the Commissioning Team. The terms Commissioning Provider, Commissioning Firm, Lead Commissioning Specialist, Commissioning Specialist, and Commissioning Authority (CA or CxA) when used by sustainable Third Party Certification (TPC) programs, are interchangeable.

Commissioning Authority - The Government retains the authority for oversight and assurance of the entire commissioning process, and final approval of all commissioning deliverables.

Government Acceptance Testing Representatives - Government Acceptance Testing Representatives perform the inherently Governmental function of technical oversight and quality assurance for critical systems, and is distinctly separate from the commissioning process. Government Acceptance Testing Representatives witness final testing of critical systems and report systems' acceptance to the COR. Submittals to be surveilled and approved by Government Acceptance Testing Representatives are identified in Section 01 33 00 SUBMITTAL PROCEDURES. Testing required to be witnessed by Government Acceptance Testing Representatives are identified in system level sections.

1.3 COMMUNICATION WITH THE GOVERNMENT

The Lead Commissioning Specialist (CxC) must submit all plans, schedules, reports, and documentation directly to the Contracting Officer's Representative concurrent with submission to the QC Manager.

The Lead Commissioning Specialist must have direct communication with the Contracting Officer's Representative regarding all elements of the commissioning process; however, the Government has no direct contract authority with the Lead Commissioning Specialist.

1.4 COMMUNICATION WITH GOVERNMENT ACCEPTANCE TESTING REPRESENTATIVES

The QC Manager must communicate directly with the Government Acceptance Testing Representatives and Contracting Officer's Representative regarding Government acceptance testing activities. Inform the Contracting Officer's Representative when systems are ready for testing to be witnessed by Government Acceptance Testing Representatives, and allow access to the construction site and system(s) to be tested.

1.5 SYSTEMS TO BE COMMISSIONED

Coordinate commissioning and quality control activities for the following systems, equipment, and associated controls. System-specific requirements are located in the associated specification Sections. Commission the following systems, equipment, and associated controls in accordance with this section and the inspection, testing, and quality control requirements of their respective sections:

Heating, ventilating, air-conditioning, and refrigeration systems (mechanical and passive) and associated controls

Lighting systems: automatic and manual daylighting controls, occupancy sensing devices, automatic shut-off controls, time switching, and other lighting control devices, and dimming systems

Domestic hot-water systems and controls

Energy and building management and demand-control systems

Building Envelope: air tightness for the entire building envelope (systems, components, and assemblies).

1.6 COMMISSIONING TEAM

The Commissioning team will include, but is not limited to the following team members.

Ensure all Construction Activities for systems to be commissioned are coordinated with the appropriate commissioning team members.

- a. Lead Commissioning Specialist (Cx/C)
- b. Quality Control Manager (QCM)
- c. Sub-Contractor Representatives for each trade responsible for construction/installation of systems to be commissioned
- d. Construction Manager (CM)
- e. Designer of Record (DOR)
- f. Technical Commissioning Specialists for each system to be commissioned
- g. TAB Representative
- h. Equipment manufacturer representatives
- i. Government Contracting Officer
- j. Government Representatives
- k. Government Acceptance Testing Representatives
- l. Installation Maintenance Representative
- m. Facility End User
- n.

1.7 PROJECT SCHEDULE

Include the following tasks in the project schedule required by Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS). Ensure sufficient time is scheduled to complete each item. The order of items listed below is not intended to imply a specified sequence:

- a. Submission and approval of the Commissioning Firm Qualifications
- c. Submission and approval of the Design Review Report
- d. Submission and approval of the Interim and Final Construction Phase Commissioning Plans
- e. Commissioning Kickoff Coordination Meeting
- f. Regular Commissioning Coordination Meetings
- g. Installation of permanent utilities (gas, water, electric)
- h. Building Envelope Construction

- i. Submission and approval of the Completed Building Envelope Inspection Checklists
- j. Manufacturer's Equipment Start-Up for each of the systems to be commissioned
- k. Submission and approval of the Completed Pre-Functional Checklists
- l. Submission and approval of Certificate of Readiness for each system to be commissioned
- m. Functional Performance Testing for each system to be commissioned
- n. Integrated Systems Tests
- o. Post-test deficiency correction for each system to be commissioned
- p. Re-Testing
- r. Training for each of the systems to be commissioned
- s. Submission and approval of the Initial and Final Commissioning Reports
- t. Seasonal Testing
- u. Final testing required to be witnessed by Government Acceptance Testing Representatives, as identified in system level sections.
- w. Updated Commissioning report

1.8 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Design Review Report; G

Interim Construction Phase Commissioning Plan; G

Final Construction Phase Commissioning Plan; G; S

Initial Commissioning Report; G

Issues Log; G

Completed Pre-Functional Checklists; G

Completed Building Envelope Inspection Checklists; G

SD-07 Certificates

Commissioning Firm; G

Certificate Of Readiness; G

SD-11 Closeout Submittals

Final Commissioning Report; G

1.9 COMMISSIONING FIRM

Employ the services of a Commissioning Firm and all Commissioning Specialists required to perform work for this project. The Commissioning Firm must be a first-tier subcontractor that is financially and corporately independent from contractor and all other subcontractors and the Designer of Record.

- a. Submit the Commissioning Firm's and Commissioning Specialists' qualifications, including the name of the firm and each CxC and each certification, no later than 30 calendar days after Notice to Proceed.
- b. If, for any reason, a specialist loses a certification during this period, immediately notify the Contracting Officer and submit another Commissioning Specialist for approval. Validate all work performed for this project by the CxC who lost a certification by an approved successor.

1.9.1 Commissioning Specialists (CxC)

Assign Lead Commissioning Specialist and other appropriate Commissioning Specialists for the systems to be commissioned.

1.9.1.1 Lead Commissioning Specialist (CxC)

Lead Commissioning Specialist (CxC) coordinates all aspects of the commissioning process. Duties include leading and overseeing the commissioning work, and acting as the primary point of contact for the commissioning work. CxC may serve as a systems Specialist if all requirements for both designations are met. CxC must have a minimum of five years of commissioning experience, including two projects of similar size and complexity to this project.

CxC must be certified in one of the following:

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 Building Commissioning Professional (BCxP).

1.9.1.2 Commissioning Specialists

Commissioning Specialists with the following qualifications must perform the technical work associated with each system to be commissioned:

- a. Mechanical Commissioning Specialist: The technical work associated with mechanical systems to be commissioned must be performed by a Commissioning Specialist certified by NEBB, ACG, ICB/TABB, AEE, University of Wisconsin-Madison, ASHRAE, or BCA in the commissioning of HVAC systems with five years of experience in the commissioning of HVAC systems.
- b. Electrical Commissioning Specialist: The technical work associated with electrical systems to be commissioned must be performed by an engineering technician with five years of experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.
- c. Building Envelope Commissioning Specialist: 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 or a professional with training and certification as an Air Barrier Installer from the Air Barrier Association of America (ABAA) or other third party air barrier association..

1.9.2 Commissioning Standard

Comply with the requirements of the commissioning standard under which the Commissioning Firm and 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 these acceptable standards: [ACG Commissioning Guideline](#), [NEBB Commissioning Standard](#), [ANSI/SMACNA 014](#), or [ASHRAE 202](#). Comply with applicable NETA 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 by the body responsible for the Commissioning Standard at the time of project award.
- g. If there is a conflict between the requirements of the contract documents and the commissioning standard used, the contract documents take precedent.

1.10 SUSTAINABILITY THIRD PARTY CERTIFICATION (TPC)

The Commissioning Specialist must perform all commissioning activities,

coordination, and submittals required by the sustainability Third Party Certification (TPC) program applied to this project, in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

1.11 ISSUES LOG

The Commissioning Specialist develops and maintain an Issues Log for the systems to be commissioned. The issues log documents and tracks resolution of deficiencies identified during submittal reviews, inspection, and testing. 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. For each issue, the Issues Log includes, but is not limited to, a unique reference number, description of the issue with contract requirement referenced, location of or equipment name/tags exhibiting the issue, the initials of the individual's name whom reported the issue, the date of first observation, the proposed resolution of the issue and date proposed, the date of any subsequent observations with applicable additional information, and the date of implementation of the final resolution of the issue as confirmed by the Commissioning Specialist and Contracting Officer. Issues must not be deleted from the issues log.

CxC must submit the Issues Log monthly and within three working days from changes to the Issue Log. The CxC is responsible for distributing the Issues Log to the Commissioning Team. The QC manager is responsible for notifying the CxC and Contracting Officer of outstanding deficiencies and tracking them to resolution in accordance with Section 01 45 00.00 20 QUALITY CONTROL, "Quality Control Plan".

1.12 CERTIFICATE OF READINESS

Prior to scheduling Functional Performance Tests, the Quality Control Manager must issue a Certificate of Readiness for each system, certifying that pre-functional checks have been completed, open issues have been resolved, and the system is ready for Functional Performance Testing. The Certificate of Readiness must include, for each system to be commissioned, equipment and system start-up reports; completed Building Envelope Inspection Checklists; the Air Leakage Test Reports and Diagnostic Test Reports; completed Pre-Functional Checklists; Testing, Adjusting, and Balancing (TAB) Report; Issues Log; and HVAC Controls Start-Up Reports to the extent applicable to the system. Sign and date the Certificate of Readiness, and include signatures and dates from the CxC; the Quality Control Representative; the Mechanical, Electrical, Controls, Building Envelope, and TAB subcontractor representatives.

Submit the Certificate of Readiness for each system 14 calendar days prior to Functional Performance Tests of that system. Do not schedule Functional Performance Tests for a system until the Certificate of Readiness is approved by the Government.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 DESIGN REVIEW

The CxC and other Commissioning Specialists must review design documents.

The design review must include verifying the Design Plans and Specifications for the systems to be commissioned are prepared in accordance with the contract documents.

Provide a Design Review Report identifying discrepancies or deficiencies that would prevent the systems to be commissioned from operating or performing in accordance with the design requirements or being safely maintained. Report must include individual list of each deficiency and corresponding corrective action necessary for proper system performance. The Contracting Officer, the CxC, and the Designers of Record for the associated systems must meet, discuss, and resolve any outstanding items contained in the report no later than 14 calendar days after submission of the report. The CxC must verify that their review comments have been adequately addressed in subsequent design submittals.

3.2 CONSTRUCTION SUBMITTAL REVIEWS

Coordinate construction submittal document reviews for commissioned systems and assemblies with the CxC. The commissioning submittal review does not replace the designer of record (DoR) or Government submittal review, in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

The CxC must identify construction submittals to be provided by the contractor for the commissioned systems. The CxC must evaluate construction submittals for compliance with the contract documents. Include a copy of the submittal document review transmittal and response in the Commissioning Report.

3.3 COMMISSIONING KICKOFF MEETING

Conduct a Commissioning Kickoff Meeting, led by the CxC, after approval of the Commissioning Firm and Commissioning Specialists, and no later than 60 days following construction notice to proceed. 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 section.

The Quality Control team, Designer of Record, and the Government Acceptance Testing Representatives and other Government team members must attend this meeting. Invite the User and Contracting Officer to attend this meeting.

3.4 REGULAR COMMISSIONING COORDINATION MEETINGS

The Quality Control team, Designer of Record, and the Government Acceptance Testing Representatives and other Government team members must attend this meeting. Invite the User and Contracting Officer to attend this meeting.

CxC must conduct monthly commissioning coordination meetings when installation of commissioned systems begins. Provide status of commissioned systems, open issues log items, outstanding submittals, and upcoming commissioning activities. Conduct bi-weekly commissioning coordination meetings within 30 days of the scheduled date for functional performance testing.

3.5 CONSTRUCTION PHASE COMMISSIONING PLANS

The Interim Construction Phase Commissioning Plan identifies 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. Submit the Interim Construction Phase Commissioning Plan 14 calendar days after the Construction Commissioning Coordination Meeting and 14 days prior to the start of construction of the building envelope.

The Final Construction Phase Commissioning Plan includes the information provided in the Interim Construction Phase Commissioning Plan as well as 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. Submit the Final Construction Phase Commissioning Plan no later than 90 calendar days prior to the start of Pre-Functional Checks. Once approved, file the approved plan in the Sustainability eNotebook.

3.5.1 Template Building Envelope Inspection Checklists

The Building Envelope Commissioning Specialist must develop the Template Building Envelope Inspection Checklists to verify the building materials and construction maintain the required air tightness of the building envelope system.

3.5.2 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. Refer to paragraph PRE-FUNCTIONAL CHECKS. Pre-functional checklists must be tailored to verify the specific installation requirements and details of the construction documents and manufacturer's instructions.

3.5.3 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. Refer to paragraph FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTS. 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 approved 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.

3.5.4 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 interactive operations between systems performs in accordance with the contract. Refer to paragraph FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTS. 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 approved by the Government
- c. Test conditions including date and beginning and ending time
- d. Identification of the equipment and systems involved in the test
- e. 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.
- f. Space for comments for each test item.

3.5.5 Building Envelope Inspection and Testing

Document building envelope inspection by the commissioning team using the approved Template Building Envelope Inspection Checklists. Indicate commissioning team member inspection and validation 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. Submit the initialed and [Completed Building Envelope Inspection Checklists](#) no later than 14 calendar days after completion of inspection of all checklist items.

The Building Envelope Commissioning Specialist must conduct at least two site visits to the site to observe construction of the building envelope in-progress, each time reviewing the in-progress checklists to ensure that

the commissioning team is inspecting the building envelope as required.

The Building Envelope Commissioning Specialist must witness the building envelope pressure tests and diagnostic tests specified in Section 07 05 23 PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS; review the resulting reports; and provide recommendations for correction of any deficiencies or further testing.

3.6 PRE-FUNCTIONAL CHECKS

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 validation of each Pre-Functional Checklist item by initials. Validation of each Pre-Functional Checklist item by each team member indicates that item conforms to the contract documents and validated design in their area of responsibility. Commissioning Specialist validation of each Pre-Functional Checklist item indicates that each item has been installed correctly and in accordance with contract documents. Submit the initialed and Completed Pre-Functional Checklists no later than 7 calendar days after completion of inspection of all checklists items for each system. Include manufacturer start-up checklists associated with equipment with the submission of the Pre-Functional Checklists.

3.7 FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTS

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. Provide all materials, services, and labor required to perform the Pre-Functional Checks, Building Envelope Inspection, Integrated Systems Tests, and Functional Performance Tests.

Commissioning Specialist's duties include leading and documenting all tests for the systems to be commissioned with appropriate sub-contractors performing the Tests. The representatives listed in the paragraph Commissioning Team must attend the 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.

3.7.1 Test Scheduling and Coordination

Conduct Initial Functional Performance Tests as soon as all contract work is completed, regardless of the season. Develop and implement means of artificial loading to demonstrate, to a reasonable level of confidence, the ability of the HVAC systems to handle peak seasonal loads. 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.

Functional Performance Tests and Integrated Systems Tests must be performed with the CxC present. Government reserves the right to witness all tests. Coordinate test schedule with Government representatives.

3.7.2 Testing Procedures

Functional performance testing is conducted by simulating conditions at control devices to initiate a control system response. Over-writing control input values through the control system is not allowed unless approved by the Contracting Officer. Do not simulate conditions when damage to the system or building may result.

Follow the Functional Performance Test from the approved Final Construction Phase Commissioning Plan. Perform Functional Performance Tests for each item of equipment and each system required to be commissioned. Verify all sensor calibrations, control responses, safeties, interlocks, operating modes, sequences of operation, capacities, lighting levels, and all other performance requirements comply with contract, regardless of the specific items listed within the checklists provided. In general, testing must progress from equipment or components to subsystems to systems to interlocks and connections between systems. Commissioning Specialists are responsible for determining the order of components and systems to be tested. Indicate validation of each item of equipment and systems tested by signature of each commissioning team member for each test. The Quality Control Representative, Commissioning Specialists, and Contracting Officer's Representative, if present, must indicate validation after the equipment and systems are free of deficiencies.

3.7.3 Integrated Systems Tests

Follow the Integrated Systems Test Checklists from the approved Final Construction Phase Commissioning Plan. 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.

3.7.4 Sample Strategy

Perform Functional Performance Tests and Integrated Systems Tests for all systems and equipment to be commissioned using the sample strategy identified herein. Complete a Functional Performance Test Checklist for each item of equipment or system to be tested. For sample sizes less than 100 percent for similar equipment, the Contracting Officer's Representative reserves the right to select the specific equipment or system to be tested during testing. Perform Integrated Systems Tests for all systems and equipment having interactive operation. Complete an Integrated Systems Test Checklist for each item of equipment or system.

Test all central plant equipment, primary air handling units, and process cooling or heating equipment. Test all system-level equipment serving multiple zones. Twenty percent sample testing is allowed for large groups of identical equipment with identical controllers serving single zones such as air terminal units, fan coil units, unitary equipment, lighting zones, and plumbing fixtures.

3.7.4.1 100 Percent Sample Procedures

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.

3.7.4.2 Less than 100 Percent Sample Procedures

Randomly test each sample group of identical equipment. Sample size must be at least three units. If 10 percent of the units in the first sample fail the functional performance tests, test a second sample group, the same size as the first sample group. The second sample must not include any units from the first sample group.

If 10 percent of the units in the second sample fail, test all remaining units. If at any point frequent failures occur, and testing becomes more troubleshooting than verification, the CxC may stop the testing and require the contractor to perform and document a checkout of the remaining units prior to continuing functional testing.

3.7.5 Aborted Tests and Re-Testing

Abort any test if any deficiency prevents successful completion of the test or if any required commissioning team member is not present for the test. Re-test after all deficiencies identified during the original test have been corrected. Contracting Officer may withhold payment equivalent to lost time, re-testing, and aborted tests. These costs may include salary, travel costs, and per diem for Government team members.

3.8 TRAINING PLAN

CxC must review the training plan for training associated with the equipment and systems to be commissioned, checking that each plan has the trainer name, trainer contract information, training schedule and location. Submit review at least 30 days prior to the first training event. Incorporate CxC review comments prior to submitting training plan in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Update and resubmit the training plan based on any corrective action taken.

Document training attendance using training attendance rosters and submit completed attendance rosters no later than 7 calendar days following the completion of training for each system to be commissioned.

3.8.1 Systems Manual

The Systems Manual includes 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 for all commissioned systems. Incorporate CxC review comments prior to submitting Systems Manual in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Update and resubmit the system manual information based on any corrective action taken during the warranty period.

3.9 COMMISSIONING REPORT

Submit an Initial Commissioning Report no later than 14 calendar days following commissioning team validates all Functional Performance Tests and Integrated Systems Tests, with the exception of Seasonal Tests. Submit a Final Commissioning Report upon completion of training and trend log reviews. Include the following information in the Final Commissioning Report:

- a. An executive summary describing the overall commissioning process, the results of the commissioning process, outstanding deficiencies and recommended resolutions, and seasonal testing that must be scheduled for a later date. Indicate, in the executive summary, whether the systems meet the requirements of the contract documents.
- b. A list of deficiencies discovered during the commissioning process and the corrective actions taken in the report.
- c. Completed Building Envelope Inspection Checklists, Pre-Functional Checklists, Functional Performance Test Checklists, Integrated Systems Test Checklists, the Final Construction Phase Commissioning Plan, the Issues Log, Training Attendance Rosters, the Design Review Reports, Submittal Review Report, and the approved TAB Report.

-- End of Section --

SECTION 02 41 00

DEMOLITION
08/22

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 Guideline K (2009) Guideline for Containers for Recovered Non-Flammable Fluorocarbon Refrigerants

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.6 (2006) Safety & Health Program Requirements for Demolition Operations - American National Standard for Construction and Demolition Operations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2014) Safety -- Safety and Health Requirements Manual

U.S. DEFENSE LOGISTICS AGENCY (DLA)

DLA 4145.25 (Jun 2000; Reaffirmed Oct 2010) Storage and Handling of Liquefied and Gaseous Compressed Gases and Their Full and Empty Cylinders;
<https://www.dla.mil/Portals/104/Documents/Dispositions/ddsr/docs/cylinderjointpub.pdf>

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4000.25-1-M (2006) MILSTRIP - Military Standard Requisitioning and Issue Procedures

MIL-STD-129 (2014; Rev R; Change 1 2018; Change 2 2019) Military Marking for Shipment and Storage

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1 (2016; Rev L; Change 2) Obstruction Marking and Lighting

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61 National Emission Standards for Hazardous Air Pollutants

40 CFR 82

Protection of Stratospheric Ozone

49 CFR 173.301

Shipment of Compressed Gases in Cylinders
and Spherical Pressure Vessels

1.2 PROJECT DESCRIPTION

1.2.1 Definitions

1.2.1.1 Demolition

Demolition is the process of tearing apart and removing any feature of a facility together with any related handling and disposal operations.

1.2.1.2 Demolition Plan

Demolition Plan is the planned steps and processes for managing demolition activities and identifying the required sequencing activities and disposal mechanisms.

1.2.2 Demolition/Deconstruction Plan

Prepare a [Demolition Plan](#) and submit proposed demolition, and removal procedures for approval before work is started. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress, a detailed description of methods and equipment to be used for each operation and of the sequence of operations.

1.2.3 General Requirements

Do not begin demolition until authorization is received from the Contracting Officer. Remove rubbish and debris from the project site. The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer.

In the interest of occupational safety and health, perform the work in accordance with [EM 385-1-1](#), Section 23, Demolition, and other applicable Sections.

1.3 ITEMS TO REMAIN IN PLACE

Comply with FAR 52.236-9 to protect existing vegetation, structures, equipment, utilities, and improvements. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Do not overload pavements to remain.

1.3.1 Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove dust, dirt, and debris from work areas daily.

1.3.2 Trees

Protect trees within the project site which might be damaged during demolition or deconstruction, and which are indicated to be left in place, by a 6 foot high fence. Erect and secure fence a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Contracting Officer.

1.3.3 Utility Service

Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations. Prior to start of work, utilities serving each area of alteration or removal will be shut off by the Government and disconnected and sealed by the Contractor.

1.3.4 Facilities

Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the Contracting Officer. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.

1.4 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Demolition Plan; G

Existing Conditions

SD-07 Certificates

Notification; G

SD-11 Closeout Submittals

Receipts

Receipts and Bills of Laden, as specified.

1.6 QUALITY ASSURANCE

Submit timely notification of demolition projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. Notify the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSP A10.6. Comply with the Environmental Protection Agency requirements specified. Use of explosives will not be permitted.

1.6.1 Dust and Debris Control

Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to aircraft.

1.7 PROTECTION

1.7.1 Traffic Control Signs

a. Where pedestrian and driver and aircraft safety is endangered in the area of removal work, use traffic barricades with flashing lights. Anchor barricades in a manner to prevent displacement by wind, jet or prop blast. Notify the Contracting Officer prior to beginning such work.

Provide a minimum of 2 FAA type L-810 steady burning red obstruction lights on temporary structures (including cranes) over 100 feet, but less than 200 ft, above ground level. The use of LED based obstruction lights are not permitted. For temporary structures (including cranes) over 200 ft above ground level provide obstruction lighting in accordance with FAA AC 70/7460-1. Perform light construction and installation in compliance with FAA AC 70/7460-1. Lights must be operational during periods of reduced visibility, darkness, and as directed by the Contracting Officer. Maintain the temporary services during the period of construction and remove only after permanent services have been installed and tested and are in operation.

1.7.2 Protection of Personnel

Before, during and after the demolition work continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.8 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Repair or replace items to be relocated which are damaged by the Contractor with new undamaged items as approved by the Contracting Officer.

1.9 EXISTING CONDITIONS

Before beginning any demolition work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Contracting Officer showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs or electronic images with a minimum resolution of 3072 x 2304 pixels, capable of a print resolution of 300 dpi, will be acceptable as a record of existing conditions. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, alarms systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document. Submit survey results to the Contracting Officer.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

Inspect and evaluate existing structures onsite for reuse. Disassemble existing construction scheduled to be removed for reuse. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Designate materials for reuse onsite whenever possible.

3.1.1 Structures

- a. Remove existing structures indicated in their entirety including all foundation elements. Overhead and underground utility lines will be terminated as indicated. The concrete slab, walkway, and footings shall also be removed. The demolished sites will be backfilled, leveled, and seeded unless otherwise indicated. Remove sidewalks, curbs, gutters and street light bases as indicated.
- b. Demolish structures in a systematic manner from the top of the structure to the ground. Complete demolition work above each tier or floor before the supporting members on the lower level are disturbed. Demolish concrete and masonry walls in small sections. Remove structural framing members and lower to ground by means of derricks, platforms hoists, or other suitable methods as approved by the Contracting Officer.
- c. Locate demolition equipment throughout the structure and remove materials so as to not impose excessive loads to supporting walls,

floors, or framing.

- d. Building, or the remaining portions thereof, not exceeding 80 feet in height may be demolished by the mechanical method of demolition.

3.1.2 Utilities and Related Equipment

3.1.2.1 General Requirements

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Contracting Officer. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.1.2.2 Disconnecting Existing Utilities

Remove existing utilities, as indicated and uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer. When utility lines are encountered but are not indicated on the drawings, notify the Contracting Officer prior to further work in that area. Remove meters and related equipment and deliver to a location on the station in accordance with instructions of the Contracting Officer.

3.1.3 Chain Link Fencing

Remove chain link fencing, gates and other related salvaged items scheduled for removal.

3.1.4 Paving and Slabs

Remove concrete and asphaltic concrete paving and slabs including aggregate base as indicated to a depth of 16 inches below new finish grade. Provide neat sawcuts at limits of pavement removal as indicated. Move, grind and store pavement and slabs designated to be recycled and utilized in this project as directed by the Contracting Officer. Remove pavement and slabs not to be used in this project from the installation at Contractor's expense.

3.1.5 Concrete

Saw concrete along straight lines to a depth of a minimum 2 inch. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished work, and the remaining concrete is sound. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete.

3.1.6 Miscellaneous Metal

Salvage shop-fabricated items such as access doors and frames, steel gratings, metal ladders, wire mesh partitions, metal railings, metal windows and similar items as whole units. Salvage light-gage and cold-formed metal framing, such as steel studs, steel trusses, metal gutters, roofing and siding, metal toilet partitions, toilet accessories and similar items. Recycle scrap metal as part of demolition and

deconstruction operations. Provide separate containers to collect scrap metal and transport to a scrap metal collection or recycling facility, in accordance with the Waste Management Plan.

3.1.7 Patching

Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces, using on-site materials when available. Where new work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new work. Make finished surfaces of patched area flush with the adjacent existing surface and match the existing adjacent surface as closely as possible to texture and finish. Provide patching as specified and indicated, and include the following:

- a. Concrete: Completely fill holes and depressions, left as a result of removals in existing masonry walls to remain.

3.1.8 Electrical Equipment and Fixtures

Salvage motors, motor controllers, and operating and control equipment that are attached to the driven equipment. Salvage wiring systems and components. Box loose items and tag for identification. Disconnect primary, secondary, control, communication, and signal circuits at the point of attachment to their distribution system.

3.1.8.1 Fixtures

Remove and salvage electrical fixtures. Salvage unprotected glassware from the fixture and salvage separately. Salvage incandescent, mercury-vapor, and fluorescent lamps and fluorescent ballasts manufactured prior to 1978, boxed and tagged for identification, and protected from breakage.

3.1.8.2 Electrical Devices

Remove and salvage switches, switchgear, transformers, conductors including wire and nonmetallic sheathed and flexible armored cable, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items. Box and tag these items for identification according to type and size.

3.1.8.3 Wiring Ducts or Troughs

Remove and salvage wiring ducts or troughs. Dismantle plug-in ducts and wiring troughs into unit lengths. Remove plug-in or disconnecting devices from the busway and store separately.

3.1.8.4 Conduit and Miscellaneous Items

Salvage conduit except where embedded in concrete or masonry. Consider corroded, bent, or damaged conduit as scrap metal. Sort straight and undamaged lengths of conduit according to size and type. Classify supports, knobs, tubes, cleats, and straps as debris to be removed and disposed.

3.2 CONCURRENT EARTH-MOVING OPERATIONS

Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition or deconstruction work in areas occupied by structures to be demolished or deconstructed until all demolition and deconstruction in the area has been completed and debris removed. Fill holes, open basements and other hazardous openings.

3.3 DISPOSITION OF MATERIAL

3.3.1 Title to Materials

Except for salvaged items specified in related Sections, and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, become the property of the Contractor and must be removed from Government property. Materials approved for storage by the Contracting Officer must be removed before completion of the contract. Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

3.3.2 Disposal of Ozone Depleting Substance (ODS)

Class I and Class II ODS are defined in Section, 602(a) and (b), of The Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting [AHRI Guideline K](#) suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling. Turn over recovered ODS to the Contracting Officer. Dispose products, equipment and appliances containing ODS in a sealed, self-contained system (e.g. residential refrigerators and window air conditioners) in accordance with [40 CFR 82](#). Submit [Receipts](#) or bills of lading, as specified. Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped to the Defense Depot, Richmond, Virginia.

3.3.2.1 Special Instructions

No more than one type of ODS is permitted in each container. Apply a warning/hazardous label to the containers in accordance with Department of Transportation regulations. Provide a tag with the following information on all cylinders including but not limited to fire extinguishers, spheres, or canisters containing an ODS:

- a. Activity name and unit identification code
- b. Activity point of contact and phone number
- c. Type of ODS and pounds of ODS contained
- d. Date of shipment
- e. National stock number (for information, call (804) 279-4525).

3.3.2.2 Fire Suppression Containers

Deactivate fire suppression system cylinders and canisters with electrical

charges or initiators prior to shipment. Also, safety caps must be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

3.3.3 Transportation Guidance

Ship all ODS containers in accordance with MIL-STD-129, DLA 4145.25 (also referenced one of the following: Army Regulation 700-68, Naval Supply Instruction 4440.128C, Marine Corps Order 10330.2C, and Air Force Regulation 67-12), 49 CFR 173.301, and DOD 4000.25-1-M.

3.3.4 Unsalvageable and Non-Recyclable Material

Dispose of unsalvageable and non-recyclable combustible material off the site.

3.4 CLEANUP

Remove debris and rubbish from basement and similar excavations. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.5 DISPOSAL OF REMOVED MATERIALS

3.5.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations with all applicable federal, state and local regulations.

3.5.2 Burning on Government Property

Burning of materials removed from demolished and deconstructed structures will not be permitted on Government property.

3.5.3 Removal to Spoil Areas on Government Property

Transport noncombustible materials removed from demolition and deconstruction structures to designated spoil areas on Government property.

3.5.4 Removal from Government Property

Transport waste materials removed from demolished and deconstructed structures, except waste soil, from Government property for legal disposal. Dispose of waste soil as directed.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 30 00

CAST-IN-PLACE CONCRETE
02/19, CHG 4: 08/22

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 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	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 308.1	(2011) Specification for Curing Concrete
ACI SP-2	(2007; Abstract: 10th Edition) ACI Manual of Concrete Inspection
ACI SP-15	(2011) Field Reference Manual: Standard Specifications for Structural Concrete ACI 301-05 with Selected ACI References

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 A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A184/A184M	(2019) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2022) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A884/A884M	(2019) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire 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 A1022/A1022M	(2016b) Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement
ASTM A1060/A1060M	(2016b) Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1064/A1064M	(2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2022) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2021) Standard Test Method for Compressive Strength of Cylindrical

Concrete Specimens

ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2022a) Standard Specification for Ready-Mixed Concrete
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2017a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
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	(2022) 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 C311/C311M	(2022) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C330/C330M	(2017a) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C494/C494M	(2019; E 2022) Standard Specification for Chemical Admixtures for Concrete
ASTM C567/C567M	(2019) Determining Density of Structural Lightweight Concrete
ASTM C595/C595M	(2021) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2022) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan

for Use in Concrete

ASTM C803/C803M	(2018) Standard Test Method for Penetration Resistance of Hardened Concrete
ASTM C845/C845M	(2018) Standard Specification for Expansive Hydraulic Cement
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 C989/C989M	(2022) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1012/C1012M	(2018b) Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1074	(2019) 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	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1157/C1157M	(2020a) Standard Performance Specification for Hydraulic Cement
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2021) 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 C1567	(2021) Standard Test Method for Potential

Alkali-Silica Reactivity of Combinations
of Cementitious Materials and Aggregate
(Accelerated Mortar-Bar Method)

ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1778	(2016) Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
ASTM D412	(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D1751	(2018) 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 D2835	(1989; R 2017) Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D5759	(2012; R 2020) 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 E96/E96M	(2022) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E329	(2021) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E1155	(2020) 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

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2018) 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. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

1.2 DEFINITIONS

- a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, slag cement, and silica fume.
- 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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G

Quality Control Personnel Certifications; G

Quality Control Organizational Chart

Laboratory Accreditation; G

Maturity Method Data

SD-02 Shop Drawings

Reinforcing Steel; G

SD-03 Product Data

Joint Sealants;

Joint Filler;

Formwork Materials

Recycled Aggregate Materials;

Cementitious Materials;

Vapor Retarder

Concrete Curing Materials

Reinforcement;

Liquid Chemical Floor Hardeners and Sealers

Admixtures

Mechanical Reinforcing Bar Connectors

Waterstops

Biodegradable Form Release Agent

Nonshrink Grout

SD-04 Samples

SD-05 Design Data

Concrete Mix Design; G

SD-06 Test Reports

Concrete Mix Design; G

Fly Ash

Pozzolan

Slag Cement

Aggregates

Tolerance ReportCompressive Strength Tests; G

Unit Weight of Structural Concrete

Air Content

Slump Tests

Water

SD-07 Certificates

Reinforcing Bars

Welder Qualifications

Field Testing Technician and Testing Agency

SD-08 Manufacturer's Instructions

Joint Sealants;

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 retarder, 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 [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 versus 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. Required average strength can be documented by field experience if field strength test data are available and represent a single group of at least 10 consecutive strength tests for one mixture, using materials and conditions similar to those expected for work, and encompassing a period of not less than 45 days. The average of field strength tests shall equal or exceed f_{cr}' . Changes in materials, conditions, and proportions within the test record shall not have been more closely restricted than those for the proposed work. Test records shall not be more than 24 months old. Obtain mix design approval from the contracting officer prior to concrete placement.

1.6.2 Shop Drawings

1.6.2.1 [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 Test Reports

1.6.3.1 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.

1.6.3.2 Slag Cement

Submit test results in accordance with [ASTM C989/C989M](#) for slag cement. Submit test results performed within 6 months of submittal date.

1.6.3.3 Aggregates

Submit test results in accordance with [ASTM C33/C33M](#), or [ASTM C330/C330M](#) for lightweight aggregate, and [ASTM C1293](#) or [ASTM C1567](#) as required in the paragraph titled ALKALI-AGGREGATE REACTION.

1.6.4 Field Samples

1.6.5 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.

1.6.6 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.

1.6.6.1 Quality Manager Qualifications

The quality manager must hold a current license as a professional engineer in a U.S. state or territory with experience on at least five similar projects. Evidence of extraordinary proven experience may be considered by the Contracting Officer as sufficient to act as the Quality Manager.

1.6.6.2 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**.

1.6.7 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.

1.6.8 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 competent in concrete materials 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 ENVIRONMENTAL REQUIREMENTS

Provide space ventilation according to material manufacturer recommendations, at a minimum, during and following installation of concrete curing compound and sealer. Maintain one of the following ventilation conditions during the curing period or for 72 hours after installation:

- a. Supply 100 percent outside air 24 hours a day.
- b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 84 degrees F and humidity is between 30 percent and 60 percent.
- c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

1.7.1 Submittals for Environmental Performance

- a. Provide data indication the percentage of post-industrial pozzolan (fly ash, slag cement) cement substitution as a percentage of the full product composite by weight.
- b. Provide data indicating the percentage of post-industrial and post-consumer recycled content aggregate.
- c. Provide product data indicating the percentage of post-consumer recycled steel content in each type of steel reinforcement as a percentage of the full product composite by weight.
- d. Provide product data stating the location where all products were manufactured
- e. For projects using FSC certified formwork, provide chain-of-custody documentation for all certified wood products.
- f. For projects using reusable formwork, provide data showing how formwork is reused.
- g. Provide SDS product information data showing that form release agents meet any environmental performance goals such as using vegetable and soy based products.
- h. Provide SDS product information data showing that concrete adhesives meet any environmental performance goals including low emitting, low volatile organic compound products.

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, 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.

- c. Design formwork and shoring for load redistribution resulting from stressing of post-tensioned reinforcement. Ensure that formwork allows movement resulting from application of prestressing force.
- 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 1/400 of 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.
- m. Submit procedure for reshoring and backshoring, including drawings signed and sealed by a licensed design engineer. Include on shop drawings the formwork removal procedure and magnitude of construction loads used for design of reshoring or backshoring system. Indicate in procedure the magnitude of live and dead loads assumed for required capacity of the structure at time of reshoring or backshoring.
- n. Submit manufacturer's product data on form liner proposed for use with each formed surface.

2.1.1.1 Wood Forms

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.

2.1.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to [NIST PS 1](#), B-B, concrete form, not less than [5/8-inch](#) thick.

2.1.1.1.2 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

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

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 10 percent post-consumer recycled content, or a minimum of 20 percent 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 at least $3/4$ in. for Surface Finish-2.0 or Surface Finish-3.0, 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 Waterstops

Submit manufacturer's data sheet on waterstop materials and splices.

2.2.2.1 PVC Waterstop

Polyvinylchloride waterstops must conform to [COE CRD-C 572](#).

2.2.2.2 Rubber Waterstop

Rubber waterstops must conform to [COE CRD-C 513](#).

2.2.2.3 Thermoplastic Elastomeric Rubber Waterstop

Thermoplastic elastomeric rubber waterstops must conform to [ASTM D471](#).

2.2.2.4 Hydrophilic Waterstop

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water must conform to the following requirements when tested in accordance to [ASTM D412](#): Tensile strength 420 psi minimum; ultimate elongation 600 percent minimum. Hardness must be 50 minimum on

the type A durometer and the volumetric expansion ratio in distilled water at 70 degrees F must be 3 to 1 minimum.

2.2.3 Biodegradable Form Release Agent

- a. Provide form release agent that is colorless, biodegradable, and water-based, with a zero VOC content.
- 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. Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.
- d. Submit manufacturer's product data on formwork release agent for use on each form-facing material.

2.2.4 Chamfer Materials

Use lumber materials with dimensions of 3/4 x 3/4 in.

2.2.5 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, beams, and girders. If a beam intersects a girder within the middle one-third of girder span, the distance between the construction joint in the girder and the edge of the beam must be at least twice the width of the larger member.
- c. For members with post-tensioning tendons, locate construction joints where tendons pass through centroid of concrete section.
- d. Locate construction joints in walls and columns at underside of slabs, beams, or girders and at tops of footings or slabs.
- e. Make construction joints perpendicular to main reinforcement.
- f. Provide movement joints where indicated in Contract Documents or in accepted alternate locations.
- g. Submit location and detail of movement joints if different from those indicated in Contract Documents.
- h. Submit manufacturer's data sheet on expansion joint materials.
- i. Provide keyways where indicated in Contract Documents.

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 II .
- 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. If fly ash is used it shall range from 15 to 20 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, it shall not be used. 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 Slag Cement

ASTM C989/C989M, Grade 120.

2.3.1.4 Silica Fume

Silica fume must conform to **ASTM C1240**, including the optional limits on reactivity with cement alkalis. Silica fume may be furnished as a dry, densified material or as slurry. Proper mixing is essential to accomplish proper distribution of the silica fume and avoid agglomerated silica fume which can react with the alkali in the cement resulting in premature and extensive concrete damage. Supervision at the batch plant, finishing, and curing is essential. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume. This representative must be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume. A High Range Water Reducing admixture (HRWRA) must be used with silica fume.

2.3.1.5 Other Supplementary Cementitious Materials

Natural pozzolan must be raw or calcined and conform to [ASTM C618](#), Class N, including the optional requirement for uniformity.

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 $\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3$ 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, depending on local availability and conforming to requirements of the mix design. Recycled aggregate to include: recovered concrete recovered stone that meets the aggregate requirements specified. 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 unless approved by the contracting officer.
- e.
- 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. 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 Hardeners and Sealers

- a. Hardener must be a colorless aqueous solution containing a blend of inorganic silicate or silicate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufactures instructions for placement of

liquid chemical floor hardener.

- b. Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content. Submit manufactures instructions for placement of sealers.

2.4.4 Expansion/Contraction Joint Filler

ASTM D1751 . Material must be 1/2 inch thick, unless otherwise indicated.

2.4.5 Joint Sealants

Submit manufacturer's product data, indicating VOC content.

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.

2.4.5.4 Lubricant for Preformed Compression Seals

ASTM D2835.

2.4.6 Vapor Retarder

ASTM E1745 Class C polyethylene sheeting, minimum 10 mil thickness or other equivalent material with a maximum permeance rating of 0.04 perms per ASTM E96/E96M.

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

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.

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 must meet the following requirements:

Nominal maximum size of aggregate, in.	Minimum cementitious material content, pounds per cubic yard
1-1/2	470
1	520
3/4	540
3/8	610

- 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. Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3. 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.
- h. Concrete for slabs to receive a hard-troweled finish must not contain an air-entraining admixture or have a total air content greater than 3 percent.
- 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	Exposure Categories^	Miscellaneous Requirements
Footings	3000 at 28 days	S0 ; C1 ; W1; F0	Max. slump: 6 in. Nominal maximum aggregate size must be 1 in.

	Minimum $f'c$ psi	Exposure Categories^	Miscellaneous Requirements
Beams and elevated slabs	3000 at 28 days	S0 ; C1 ; W1; F0	Nominal maximum aggregate size must be 1 in.
Slabs-on-ground	3000 at 28 days	S0 ; C1 ; W1; F0	

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):

- For each aggregate used in concrete, the expansion result determined in accordance with **ASTM C1293** must not exceed 0.04 percent at one year.
- 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.
- 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:

$$LBA = (\text{cement content, pounds per cubic yard}) \times (\text{equivalent alkali content of portland cement in percent}/100 \text{ percent})$$

2.5.2.2 Freezing and Thawing Resistance

- Provide concrete meeting the following requirements based on exposure class assigned to members for freezing-and-thawing exposure in Contract Documents:

Exposure class	Maximum w/cm^*	Minimum $f'c$, psi	Air content	Additional Requirements
F0	N/A	2500		N/A
F1	0.55	3500	Depends on aggregate size	N/A

Exposure class	Maximum w/cm^*	Minimum $f'c$, psi	Air content	Additional Requirements
F2	0.45	4500	Depends on aggregate size	See limits on maximum cementitious material by mass
F3	0.40	5000	Depends on aggregate size	See limits on maximum cementitious material by mass
F3 plain concrete	0.45	4500	Depends on aggregate size	See limits on maximum cementitious material by mass

*The maximum w/cm limits do not apply to lightweight concrete.

- b. Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3. The total air content must meet the requirements of the following table:

Nominal maximum aggregate size, in.	Total air content, percent [^]	
	Exposure Class F2 and F3	Exposure Class F1
3/8	7.5	6.0
1/2	7.0	5.5
3/4	6.0	5.0
1	6.0	4.5
1-1/2	5.5	4.5
2	5.0	4.0
3	5.5	3.5

*Tolerance on air content as delivered must be plus/minus 1.5 percent.

[^]For $f'c$ greater than 5000 psi, reducing air content by 1.0 percentage point is acceptable.

- c. Submit documentation verifying compliance with specified requirements.
- d. For sections of the structure that are assigned Exposure Class F3, submit certification on cement composition verifying that concrete mixture meets the requirements of the following table:

Cementitious material	Maximum percent of total cementitious material by mass*
Fly ash or other pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM C989/C989M	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or other pozzolans, slag cement, and silica fume	50^
Total of fly ash or other pozzolans and silica fume	35^

*Total cementitious material also includes ASTM C150/C150M, ASTM C595/C595M, ASTM C845/C845M, and ASTM C1157/C1157M cement. The maximum percentages above must include:

- i. Fly ash or other pozzolans present in ASTM C1157/C1157M or ASTM C595/C595M Type IP blended cement.
- ii. Slag cement present in ASTM C1157/C1157M or ASTM C595/C595M Type IS blended cement.
- iii. Silica fume conforming to ASTM C1240 present in ASTM C1157/C1157M or ASTM C595/C595M Type IP blended cement.

^Fly ash or other pozzolans and silica fume must constitute no more than 25 percent and 10 percent, respectively, of the total mass of the cementitious materials.

2.5.2.3 Corrosion and Chloride Content

- a. Provide concrete meeting the requirements of the following table based on the exposure class assigned to members requiring protection against reinforcement corrosion in Contract Documents.
- b. Submit documentation verifying compliance with specified requirements.
- 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.
- d. The maximum water-soluble chloride ion (Cl-) content in concrete, percent by mass of cement is as follows:

Exposure class	Maximum w/cm*	Minimum f'c, psi	Maximum water-soluble chloride ion (CL-) content in concrete, percent by mass of cement
Reinforced concrete			
C0	N/A	2500	1.00
C1	N/A	2500	0.30
C2	0.4	5000	0.15
Prestressed concrete			
C0	N/A	2500	0.06
C1	N/A	2500	0.06
C2	0.4	5000	0.06

*The maximum w/cm limits do not apply to lightweight concrete.

2.5.2.4 Sulfate Resistance

- a. Provide concrete meeting the requirements of the following table based on the exposure class assigned to members for sulfate exposure.

Exposure class	Maximum w/cm	Minimum f'c, psi	Required cementitious materials-types			Calcium chloride admixture
			ASTM C150/C150M	ASTM C595/C595M	ASTM C1157/C1157M	
S0	N/A	2500	N/A	N/A	N/A	No restrictions
S1	0.50	4000	II [^]	Types with (MS) designation	MS	No restrictions
S2	0.45	4500	V [^]	Types with (HS) designation	HS	Not permitted
S3	0.45	4500	V + pozzolan or slag cement ^{**}	Types with (HS) designation plus pozzolan or slag cement ^{**}	HS + pozzolan or slag cement ^{**}	Not permitted
S3	0.40	5000	V ^{***}	Types with (HS) designation	HS	Not permitted

* For seawater exposure, other types of portland cements with tricalcium aluminate (C3A) contents up to 10 percent are acceptable if the w/cm does not exceed 0.40.

** The amount of the specific source of the pozzolan or slag cement to be used shall be at least the amount determined by test or service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slag used shall not be less than the amount tested in

accordance with **ASTM C1012/C1012M** and meeting the requirements maximum expansion requirements listed herein.

*** If Type V cement is used as the sole cementitious material, the optional sulfate requirement of 0.040 percent maximum expansion in **ASTM C150/C150M** shall be required.

^ Other available types of cement, such as Type III or Type I, are acceptable in exposure classes S1 or S2 if the C3A contents are less than 8 or 5 percent, respectively.

- b. The maximum w/cm limits for sulfate exposure do not apply to lightweight concrete.
- c. Alternative combinations of cementitious materials of those listed in this paragraph are acceptable if they meet the maximum expansion requirements listed in the following table:

Exposure class	Maximum expansion when tested using ASTM C1012/C1012M		
	At 6 months	At 12 months	At 18 months
S1	0.10 percent	N/A	N/A
S2	0.05 percent	0.10 percent^	N/A
S3	N/A	N/A	0.10 percent

^The 12-month expansion limit applies only when the measured expansion exceeds the 6-month maximum expansion limit.

2.5.2.5 Concrete Temperature

The temperature of concrete as delivered must not exceed **95°F**.

2.5.2.6 Concrete permeability

- a. Provide concrete meeting the requirements of the following table based on exposure class assigned to members requiring low permeability in the Contract Documents.

Exposure class	Maximum w/cm*	Minimum f'c, psi	Additional minimum requirements
W0	N/A	2500	None
W1	0.5	4000	None

*The maximum w/cm limits do not apply to lightweight concrete.

- 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. Submit manufacturer's certified test report for reinforcement.
- c. 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.
- d. Submit request with locations and details of splices not indicated in Contract Documents.
- e. Submit request to place column dowels without using templates.
- f. Submit request and procedure to field-bend or straighten reinforcing bars partially embedded in concrete at locations not indicated in Contract Documents. Field bending or straightening of reinforcing bars is permitted where indicated in the Contract Documents
- g. 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 S, 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](#).

2.6.2 Mechanical Reinforcing Bar Connectors

- a. Provide 125 percent minimum yield strength of the reinforcement bar.
- b. Mechanical splices for galvanized reinforcing bars must be galvanized or coated with dielectric material.
- c. Mechanical splices used with epoxy-coated or dual-coated reinforcing bars must be coated with dielectric material.
- d. Submit data on mechanical splices demonstrating compliance with this paragraph.

2.6.3 Wire

- a. Provide wire reinforcement that contains a minimum of 100 percent recycled content. Provide flat sheets of welded wire reinforcement for slabs and toppings.
- b. Plain or deformed steel wire must conform to [ASTM A1064/A1064M](#).
- c. Stainless steel wire must conform to [ASTM A1022/A1022M](#).
- d. Epoxy-coated wire must conform to [ASTM A884/A884M](#). Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated wires must be repaired. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire, wire must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by [ASTM A884/A884M](#). Fading of coating color shall not be cause for rejection of epoxy-coated wire reinforcement.

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.
- d. Epoxy-coated welded wire reinforcement must conform to [ASTM A884/A884M](#). Coating damage incurred during shipment, storage, handling, and

placing of epoxy-coated welded wire reinforcement must be repaired in accordance with [ASTM A884/A884M](#). Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by [ASTM A884/A884M](#). Fading of coating color shall not be cause for rejection of epoxy-coated welded wire reinforcement.

- e. Stainless steel welded wire reinforcement must conform to [ASTM A1022/A1022M](#).
- f. Zinc-coated (galvanized) welded wire reinforcement must conform to [ASTM A1060/A1060M](#). Coating damage incurred during shipment, storage, handling, and placing of zinc-coated (galvanized) welded wire reinforcement must be repaired in accordance with [ASTM A780/A780M](#). If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area shall include repaired areas damaged before shipment as required by [ASTM A1060/A1060M](#).

2.6.5 Reinforcing Bar Supports

- a. Provide reinforcement support types within structure as required by Contract Documents. Reinforcement supports must conform to [CRSI RB4.1](#). Submit description of reinforcement supports and materials for fastening coated reinforcement if not in conformance with [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.
- c. Minimum 5 percent post-consumer recycled content, or minimum 20 percent post-industrial recycled content.

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. Provide dowel pipe that is steel conforming to [ASTM A53/A53M](#).

Plate dowels must conform to [ASTM A36/A36M](#), and must be of size and spacing indicated. Plate dowel system must minimize shrinkage restraint by using a tapered shape

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.

- d. After completing welds on zinc-coated (galvanized), epoxy-coated, or zinc and epoxy dual-coated reinforcement, coat welds and repair coating damage as previously specified.

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 Reshoring

- a. Do not allow structural members to be loaded with combined dead and construction loads in excess of loads indicated in the accepted procedure.
- b. Install and remove reshores or backshores in accordance with accepted procedure.
- c. For floors supporting shores under newly placed concrete, either leave original supporting shores in place, or install reshores or backshores. Shoring system and supporting slabs must resist anticipated loads. Locate reshores and backshores directly under a shore position or as indicated on formwork shop drawings.
- d. In multistory buildings, place reshoring or backshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads.

3.3.3 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.

3.3.4 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.

3.3.5 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.

3.3.6 Form Ties

- a. For post-tensioned structures, do not remove formwork supports until stressing records have been accepted by the Contracting Officer.
- b. After ends or end fasteners of form ties have been removed, repair tie holes in accordance with **ACI 301** Section 5 requirements.

3.3.7 Forms for Concrete Pan Joist Construction

Pan-form units for one-way or two-way concrete joist and slab construction must be factory-fabricated units of the approximate section indicated. Units must consist of steel or molded fiberglass concrete form pans. Closure units must be furnished as required.

3.3.8 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.

3.3.9 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 weight of concrete in beams, slabs, 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.

3.3.10 Strength of Concrete Required for Removal of Formwork

If removal of formwork, reshoring, or backshoring 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 WATERSTOP INSTALLATION AND SPLICES

- a. Provide waterstops in construction joints as indicated.
- b. Install formwork to accommodate waterstop materials. Locate waterstops in joints where indicated in Contract Documents. Minimize number of splices in waterstop. Splice waterstops in accordance with manufacturer's written instructions. Install factory-manufactured premolded mitered corners.
- c. Install waterstops to form a continuous diaphragm in each joint. Make adequate provisions to support and protect waterstops during progress of work. Protect waterstops protruding from joints from damage.

3.4.1 PVC Waterstop

Make splices by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. Reform waterstops at splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. The spliced area, when cooled, must show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

3.4.2 Rubber Waterstop

Rubber waterstops must be spliced using cold bond adhesive as recommended by the manufacturer.

3.4.3 Thermoplastic Elastomeric Rubber Waterstop

Fittings must be shop made using a machine specifically designed to mechanically weld the waterstop. A portable power saw must be used to miter or straight cut the ends to be joined to ensure good alignment and contact between joined surfaces. Maintain continuity of the characteristic features of the cross section of the waterstop (for example ribs, tabular center axis, and protrusions) across the splice.

3.4.4 Hydrophilic Waterstop

Miter cut ends to be joined with sharp knife or shears. The ends must be adhered with adhesive.

3.5 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.
- 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

Concrete Exposure	Member	Reinforcement	Specified cover, in.
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

- d. Cast-in-place prestressed concrete members must have concrete cover for reinforcement, ducts, and end fittings given in the following table:

Concrete	Member	Reinforcement	Specified
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	Slabs, joists, and walls	All	1
	All other	All	1-1/2
Not exposed to weather or in contact with ground	Slabs, joists, and walls	All	3/4
		Primary reinforcement	1-1/2
	Beams, columns, and tension ties	Stirrups, ties, spirals, and hoops	1

- e. Precast nonprestressed or prestressed concrete members manufactured under plant conditions must have concrete cover for reinforcement, ducts, and end fittings given in the following table:

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Exposed to weather or in contact with ground	Walls	No. 14 and No. 18 bars; tendons larger than 1-1/2 in. diameter	1-1/2
		No. 11 bars and smaller; W31 and D31 wire, and smaller; tendons and strands 1-1/2 in.	3/4
	All other	No. 14 and No. 18 bars; tendons larger than 1-1/2 in.	2
		No. 6 through No. 11 bars; tendons and strands larger than 5/8 in. diameter through 1-1/2 in.	1-1/2
		No. 5 bar, W31 or D31 wire, and smaller; tendons and strands 5/8 in. diameter and smaller	1-1/4

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 14 and No. 18 bars; tendons larger than 1-1/2 in. diameter	1-1/4
		Tendons and strands 1-1/2 in. diameter and smaller	3/4
		No. 11 bar, W31 or D31	5/8
	Beams, columns, pedestals, and tension ties	Primary reinforcement	Greater of bar diameter and 5/8 and need not exceed 1-1/2
		Stirrups, ties, spirals, and hoops	3/8

3.5.1 General

Provide details of reinforcement that are in accordance with the Contract Documents.

3.5.2 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. Place vapor barrier directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular material which could puncture the vapor barrier. In this case, a thin layer of approximately **1/2 inch** of fine graded material should be rolled or compacted over the fill before installation of the vapor barrier to reduce the possibility of puncture. Control concrete placement so as to prevent damage to the vapor barrier.

3.5.3 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.

3.5.4 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.

3.5.5 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](#). [AWS D1.4/D1.4M](#). Approve welded splices prior to use.

3.5.6 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.

3.5.7 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.

3.5.8 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.

3.5.9 Placing Reinforcement

Place reinforcement in accordance with [ACI 301](#).

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire reinforcement on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than [1 inch](#) from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than [3-1/2 by 3-1/2 inches](#), and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

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 reinforcements 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. Unless otherwise indicated, numbers, type, and spacing of supports must conform to the Contract Documents.
- f. Bending of reinforcing bars partially embedded in concrete is permitted only as specified in the Contract Documents.

3.5.10 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.

3.5.11 Concrete Protection for Reinforcement

Additional concrete protection must be in accordance with the Contract Documents.

3.5.12 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

3.6 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.

3.6.1 Measuring

Make measurements at intervals as specified in paragraphs SAMPLING and TESTING.

3.6.2 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 concrete temperature is less than 84 degrees F.
- c. Place concrete within 60 minutes if the concrete 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, within the manufacturer's recommended dosage, 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.
- e. When fibers are used, add fibers together with the aggregates and never as the first component in the mixer. Fibers must be dispensed into the mixing system using appropriate dispensing equipment and procedure as recommended by the manufacturer.

3.6.3 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.

3.7 PLACING CONCRETE

Place concrete in accordance with **ACI 301** Section 5. Concrete shall be placed within 15 minutes of discharge into non-agitating equipment.

3.7.1 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of **4 inches** greater than indicated.

3.7.2 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 coarse 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.

3.7.3 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 one hour and **50 degrees F** per 24 hours after heat application.

3.7.4 Hot Weather

Hot weather concrete must meet the requirements of **ACI 301** unless 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.

3.7.5 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.

3.8 WASTE MANAGEMENT

Provide as specified in the Waste Management Plan and as follows.

3.8.1 Mixing Equipment

Before concrete pours, designate Contractor-owned site meeting environmental standards for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.8.2 Hardened, Cured Waste Concrete

Crush and reuse hardened, cured waste concrete as fill or as a base course for pavement.

3.8.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.8.4 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. Return excess cement to supplier.

3.9 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.9.1 Defects

Repair surface defects in accordance with ACI 301 Section 5.

3.9.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even

surfaces. Finish must match adjacent finishes.

3.9.3 Formed Surfaces

3.9.3.1 Tolerances

Tolerances in accordance with ACI 117 and as indicated.

3.9.3.2 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.

3.9.3.3 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.

3.10 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. Where straightedge measurements are specified, Contractor must provide straightedge.

3.10.1 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. Grate tampers ("jitterbugs") shall not be used.

3.10.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. Finish concrete in accordance with ACI 301 Section 5 for a scratched finish.

3.10.1.2 Floated

Use for exterior slabs where not otherwise specified. Finish concrete in accordance with ACI 301 Section 5 for a floated finish.

3.10.1.3 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.

3.10.1.4 Nonslip Finish

Use on surfaces of exterior platforms, steps, and landings; and on exterior and interior pedestrian ramps. Finish concrete in accordance with ACI 301 Section 5 for a dry-shake finish. After the selected material has been embedded by the two floatings, complete the operation with a broomed finish.

3.10.1.5 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Finish concrete in accordance with ACI 301 Section 5 for a broomed finish.

3.10.1.6 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 a burlap drag. Drag a strip of clean, wet burlap from 3 to 10 feet wide and 2 feet longer than the pavement width across the slab. Produce a fine, granular, sandy textured surface without disfiguring marks. Round edges and joints with an edger having a radius of 1/8 inch.

3.10.1.7 Concrete Toppings Placement

The following requirements apply to the placement of toppings of concrete on base slabs that are either freshly placed and still plastic, or on hardened base slabs.

- a. Placing on a Fresh Base: Screed and bull float the base slab. As soon as the water sheen has disappeared, lightly rake the surface of the base slab with a stiff bristle broom to produce a bonding surface for the topping. Immediately spread the topping mixture evenly over the roughened base before final set takes place. Give the topping the finish indicated on the drawings .
- b. Bonding to a Hardened Base: When the topping is to be bonded to a floated or troweled hardened base, roughen the base by scarifying, grit-blasting, scabbling, planing, flame cleaning, or acid-etching to lightly expose aggregate and provide a bonding surface. Remove dirt, laitance, and loose aggregate by means of a stiff wire broom. Keep the clean base wet for a period of 12 hours preceding the application of the topping. Remove excess water and apply a 1:1:1/2 cement-sand-water grout, and brush into the surface of the base slab. Do not allow the cement grout to dry, and spread it only short distances ahead of the topping placement. Do not allow the temperature differential between the completed base and the topping mixture to exceed 41 degrees F at the time of placing. Place the topping and finish as indicated.

3.10.2 Flat Floor Finishes

ACI 302.1R. Construct in accordance with one of the methods recommended in Table 10.15.3a, "Slab-on-ground flatness/levelness construction guide" or Table 10.15.3b, "Suspended slab flatness/levelness construction guide" appropriate for the type of construction. ACI 117 for tolerance tested by ASTM E1155.

- a. Specified Conventional Value:

Floor Flatness (Ff) 20 minimum
Floor Levelness (FL) 15 minimum

b. Specified Industrial:

Floor Flatness (Ff) 15 minimum
Floor Levelness (FL) 10 minimum

3.10.2.1 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](#).

3.10.2.2 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.

3.10.3 Concrete Walks

Provide [4 inches](#) thick minimum. Provide contraction joints spaced every [5 linear feet](#) unless otherwise indicated. Cut contraction joints [1 inch](#) deep, or one fourth the slab thickness whichever is deeper, with a jointing tool after the surface has been finished. Provide [0.5 inch](#) thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every [50 feet](#) maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to [1/4 inch in 5 feet](#).

3.10.4 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.10.5 Curbs and Gutters

Provide contraction joints spaced every [10 feet](#) maximum unless otherwise indicated. Cut contraction joints [3/4 inch](#) deep with a jointing tool after the surface has been finished. Provide expansion joints [1/2 inch](#) thick and spaced every [100 feet](#) maximum unless otherwise indicated. Perform pavement finish.

3.10.6 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.

3.11 JOINTS

3.11.1 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:

3.11.1.1 Construction Joints for Constructability Purposes

- 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 slabs and between walls and footings; approved bulkheads may be used for slabs.

3.11.2 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.

3.11.3 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 welded wire reinforcement before placing concrete.
- c. Sawcut contraction joints into slab on ground in accordance with ACI 301 Section 5.
- e. Sawcutting will be limited to within 12 hours after set and at 1/4 slab depth.

3.11.4 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.

3.12 CONCRETE FLOOR TOPPING

3.12.1 Standard Floor Topping

Provide topping for treads and platforms of metal steel stairs and elsewhere as indicated.

3.12.1.1 Preparations Prior to Placing

- a. When topping is placed on a green concrete base slab, screed surface of base slab to a level not more than **1-1/2 inches** nor less than **1 inch** below required finish surface. Remove water and laitance from surface of base slab before placing topping mixture. As soon as water ceases to rise to surface of base slab, place topping.
- b. When topping is placed on a hardened concrete base slab, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from base slab surface, leaving a clean surface. Prior to placing topping mixture, **2-1/2-inches** minimum, slab surface must be dampened and left free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Do not allow cement grout to set or dry before topping is placed.
- c. When topping is placed on a metal surface, such as metal pans for steel stairs, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from metal surface.

3.12.1.2 Placing

Spread standard topping mixture evenly on previously prepared base slab or metal surface, brought to correct level with a straightedge, and struck off. Topping must be consolidated, floated, checked for trueness of surface, and refloated as specified for float finish.

3.12.1.3 Finishing

Give trowel finish standard floor topping surfaces.

Give other finishes standard floor topping surfaces as indicated.

3.12.2 Heavy-Duty Floor Topping

Provide topping where indicated.

3.12.2.1 Heavy-duty Topping Mixture

Provide mixture that consists of 1 part portland cement and 2-1/2 parts

emery aggregate or 1 part fine aggregate and 1-1/2 parts traprock coarse aggregate, by volume. Exact proportions of mixture must conform to recommendations of aggregate manufacturer. Mixing water must not exceed 3-1/4 gallons per 94-pound sack of cement including unabsorbed moisture in aggregate. Maximum slump must be 1 inch.

3.12.2.2 Base Slab

- a. Screed surface of slab to a level no more than 1-1/2 inches nor less than 1 inch below grade of finished floor.
- b. Give slab a scratch finish as specified.
- c. Preparations prior to placing.

Remove dirt, loose material, oil, grease, asphalt, paint and other contaminants from base slab surface. Prior to placing topping mixture, dampen slab surface and leave free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Allow cement grout to set or dry before topping mixture is placed.

3.12.2.3 Placing

Spread heavy-duty topping mixture evenly on previously prepared base slab, and bring to correct level with a straightedge, and strike off. Provide topping that is consolidated, floated, and checked for trueness of surface as specified for float finish, except that power-driven floats is the impact type.

3.12.2.4 Finishing

Give trowel finish heavy-duty floor topping surfaces. Provide trowel finish as specified, except that additional troweling after first power troweling must be not less than three hand-troweling operations.

3.13 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 blasting, pile driving, 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, hardener, or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.13.1 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.

3.13.2 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.

3.13.3 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, 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.

3.13.4 Curing Unformed Surfaces

- a. Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, 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 hardener of finish flooring by moisture-retaining cover curing.

3.13.5 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 one hour nor **80 degrees F** in any 24-hour period.

3.13.6 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.

3.13.7 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.14 FIELD QUALITY CONTROL

3.14.1 Aggregate Testing

3.14.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with [ASTM C136/C136M](#) and [COE CRD-C 104](#) for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall be immediately reported to the Contracting Officer, concreting shall be stopped, and immediate steps taken to correct the grading.

3.14.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with [ASTM C136/C136M](#) for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

3.14.2 Concrete Sampling

[ASTM C172/C172M](#). Collect samples of fresh concrete to perform tests specified. [ASTM C31/C31M](#) for making test specimens.

3.14.3 Concrete Testing

3.14.3.1 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.

3.14.3.2 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.

3.14.3.3 Compressive Strength Tests

ASTM C39/C39M. Make eight 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, two cylinders at 56 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.

3.14.3.4 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.

3.14.3.5 Unit Weight of Structural Concrete

ASTM C567/C567M and ASTM C138/C138M. Determine unit weight of lightweight and normal weight concrete. Perform test for every 20 cubic yards maximum.

3.14.3.6 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.

3.14.3.7 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.

3.14.3.8 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.

3.15 REPAIR, REHABILITATION AND REMOVAL

Before the Contracting Officer accepts the structure the Contractor must inspect the structure for cracks, damage and substandard concrete placements that may adversely affect the service life of the 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.

3.15.1 Crack Repair

Prior to final acceptance, all cracks in excess of 0.02 inches wide must be documented and repaired. The proposed method and materials to repair the cracks must be submitted to the Contracting Officer for approval. The proposal must address the amount of movement expected in the crack due to temperature changes and loading.

3.15.2 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.

3.15.3 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 30 53

MISCELLANEOUS CAST-IN-PLACE CONCRETE (SIDEWALKS)
05/14

PART 1 GENERAL

1.1 SUMMARY

Perform all work in accordance with ACI 318.

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 CONCRETE INSTITUTE (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2016) Specifications for Structural Concrete
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to 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)
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2022) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2018) Standard Specification for Concrete

Aggregates

ASTM C39/C39M	(2021) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94/C94M	(2022a) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
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	(2022) 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 C494/C494M	(2019; E 2022) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2022) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C685/C685M	(2017) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C1064/C1064M	(2017) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E96/E96M	(2022) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

ASTM E1745

(2017) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247

Comprehensive Procurement Guideline for Products Containing Recovered Materials

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Air-Entraining Admixture
Water-Reducing or Retarding Admixture
Curing Materials
Expansion Joint Filler Strips, Premolded
Conveying and Placing Concrete
Formwork
Mix Design Data; G
Ready-Mix Concrete
Mechanical Reinforcing Bar Connectors
Fly Ash

SD-06 Test Reports

Aggregates
Concrete Mixture Proportions; G
Compressive Strength Testing; G
Slump; G
Air Content
Water

SD-07 Certificates

Cementitious Materials
Pozzolan
CPG for recycled materials or appropriate Waiver Form
Aggregates
Delivery Tickets

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The Government retains the option to sample and test aggregates and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary to assist the Government in procurement of representative test samples. Obtain samples of aggregates at the point of batching in accordance with ASTM D75/D75M. Sample concrete in accordance with ASTM C172/C172M. Determine slump and air content in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively, when cylinders are molded. Prepare, cure, and transport

compression test specimens in accordance with [ASTM C31/C31M](#). Test compression test specimens in accordance with [ASTM C39/C39M](#). Take samples for strength tests not less than once each shift in which concrete is produced. Provide a minimum of five specimens from each sample; two to be tested at 28 days (90 days if pozzolan is used) for acceptance, two will be tested at 7 days for information and one held in reserve.

2.1.1 Strength

Acceptance test results are the average strengths of two specimens tested at 28 days (90 days if pozzolan is used). The strength of the concrete is considered satisfactory so long as the average of three consecutive acceptance test results equal or exceed the specified compressive strength, f'c, but not more than 20 percent, and no individual acceptance test result falls below f'c by more than [500 psi](#).

2.1.2 Construction Tolerances

Apply a Class "C" finish to all surfaces except those specified to receive a Class "D" finish. Apply a Class "D" finish to all post-construction surfaces which will be permanently concealed. Surface requirements for the classes of finish required are as specified in [ACI 117](#).

2.1.3 Concrete Mixture Proportions

Concrete mixture proportions are the responsibility of the Contractor. Mixture proportions must include the dry weights of cementitious material(s); the nominal maximum size of the coarse aggregate; the specific gravities, absorptions, and saturated surface-dry weights of fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per [yard](#) of concrete. Provide materials included in the mixture proportions of the same type and from the same source as will be used on the project. The specified compressive strength f'c is [3,000 psi](#) at 28 days (90 days if pozzolan is used). The maximum nominal size coarse aggregate is [3/4 inch](#), in accordance with [ACI 304R](#). The air content must be between 4.5 and 7.5 percent with a slump between [2 and 5 inches](#). The maximum water-cementitious material ratio is 0.50. Submit the applicable test reports and mixture proportions that will produce concrete of the quality required, ten days prior to placement of concrete.

2.2 MATERIALS

Submit manufacturer's literature from suppliers which demonstrates compliance with applicable specifications for the specified materials.

2.2.1 Cementitious Materials

Submit Manufacturer's certificates of compliance, accompanied by mill test reports, attesting that the concrete materials meet the requirements of the specifications in accordance with the Special Clause "CERTIFICATES OF COMPLIANCE". Also, certificates for all material conforming to EPA's Comprehensive Procurement Guidelines (CPG), in accordance with [40 CFR 247](#). Provide cementitious materials that conform to the appropriate specifications listed:

2.2.1.1 Portland Cement

[ASTM C150/C150M](#), Type I, including false set requirements with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali

content of 0.80 percent Na₂O_e (sodium oxide) equivalent.

2.2.1.2 Pozzolan

Provide pozzolan that conforms to [ASTM C618](#), Class F, including requirements of Tables 1A and 2A.

2.2.2 Aggregates

For fine and coarse aggregates meet the quality and grading requirements of [ASTM C33/C33M](#), Class Designations 4M or better. Submit certificates of compliance and test reports for aggregates showing the material(s) meets the quality and grading requirements of the specifications under which it is furnished.

2.2.3 Admixtures

Provide admixtures, when required or approved, in compliance with the appropriate specification listed. Retest chemical admixtures that have been in storage at the project site, for longer than 6 months or that have been subjected to freezing, at the expense of the Contractor at the request of the Contracting Officer and will be rejected if test results are not satisfactory.

2.2.3.1 Air-Entraining Admixture

Provide air-entraining admixture that meets the requirements of [ASTM C260/C260M](#).

2.2.3.2 Water-Reducing or Retarding Admixture

Provide water-reducing or retarding admixture meeting the requirements of [ASTM C494/C494M](#), Type A, B, or D.

2.2.4 Water

Mixing and curing water in compliance with the requirements of [ASTM C1602/C1602M](#); free of injurious amounts of oil, acid, salt, or alkali. Submit test report showing water complies with [ASTM C1602/C1602M](#).

2.2.5 Reinforcing Steel

Provide reinforcing bars conforming to the requirements of [ASTM A615/A615M](#), Grade 60, deformed. Provide welded steel wire reinforcement conforming to the requirements of [ASTM A1064/A1064M](#). Detail reinforcement not indicated in accordance with [ACI 301](#) and [ACI SP-66](#). Provide [mechanical reinforcing bar connectors](#) in accordance with [ACI 301](#) and provide 125 percent minimum yield strength of the reinforcement bar.

2.2.6 Expansion Joint Filler Strips, Premolded

Expansion joint filler strips, premolded of sponge rubber conforming to [ASTM D1752](#), Type I.

2.2.7 Formwork

Design and engineer the formwork as well as its construction in accordance with [ACI 301](#) Section 2 and 5 and [ACI 347R](#). Fabricate of wood, steel, or other approved material.

2.2.8 Form Coatings

Provide form coating in accordance with [ACI 301](#).

2.2.9 Vapor Barrier

[ASTM E1745](#) Class A polyethylene sheeting, minimum [10 mil](#) thickness or other equivalent material with a maximum permeance rating of 0.04 perms per [ASTM E96/E96M](#).

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.2.10 Curing Materials

Provide curing materials in accordance with [ACI 301](#), Section 5.

2.3 READY-MIX CONCRETE

Provide ready-mix concrete with [mix design data](#) conforming to [ACI 301](#) Part 2. Submit [delivery tickets](#) in accordance with [ASTM C94/C94M](#) for each ready-mix concrete delivery, include the following additional information:

- a. Type and brand cement
- b. Cement content in [94-pound](#) bags per cubic [yard](#) of concrete
- c. Maximum size of aggregate
- d. Amount and brand name of admixture
- e. Total water content expressed by water cementitious material ratio

PART 3 EXECUTION

3.1 PREPARATION

Prepare construction joints to expose coarse aggregate. The surface must be clean, damp, and free of laitance. Construct ramps and walkways, as necessary, to allow safe and expeditious access for concrete and workmen. Remove snow, ice, standing or flowing water, loose particles, debris, and foreign matter. Satisfactorily compact earth foundations. Make spare vibrators available. Placement cannot begin until the entire preparation has been accepted by the Government.

3.1.1 Embedded Items

Secure reinforcement in place after joints, anchors, and other embedded items have been positioned. Arrange internal ties so that when the forms are removed the metal part of the tie is not less than [2 inches](#) from concrete surfaces permanently exposed to view or exposed to water on the finished structures. Prepare embedded items so they are free of oil and other foreign matters such as loose coatings or rust, paint, and scale. The embedding of wood in concrete is permitted only when specifically authorized or directed. Provide all equipment needed to place, consolidate, protect, and cure the concrete at the placement site and in good operating condition.

3.1.2 Formwork Installation

Forms must be properly aligned, adequately supported, and mortar-tight. Provide smooth form surfaces, free from irregularities, dents, sags, or holes when used for permanently exposed faces. Chamfer all exposed joints and edges , unless otherwise indicated.

3.1.3 Production of Concrete

3.1.3.1 Ready-Mixed Concrete

Provide ready-mixed concrete conforming to [ASTM C94/C94M](#) except as otherwise specified.

3.1.3.2 Concrete Made by Volumetric Batching and Continuous Mixing

Conform to [ASTM C685/C685M](#).

3.2 CONVEYING AND PLACING CONCRETE

Convey and place concrete in accordance with [ACI 301](#), Section 5.

3.2.1 Cold-Weather Requirements

Place concrete in cold weather in accordance with [ACI 306R](#)

3.2.2 Hot-Weather Requirements

Place concrete in hot weather in accordance with [ACI 305R](#)

3.3 FINISHING

3.3.1 Temperature Requirement

Do not finish or repair concrete when either the concrete or the ambient temperature is below [50 degrees F](#).

3.3.2 Finishing Formed Surfaces

Remove all fins and loose materials , and surface defects including filling of tie holes. Repair all honeycomb areas and other defects. Remove all unsound concrete from areas to be repaired. Ream or chip surface defects greater than [1/2 inch](#) in diameter and holes left by removal of tie rods in all surfaces not to receive additional concrete and fill with dry-pack mortar. Brush-coat the prepared area with an approved epoxy resin or latex bonding compound or with a neat cement grout after dampening and filling with mortar or concrete. Use a blend of portland cement and white cement in mortar or concrete for repairs to all surfaces permanently exposed to view so that the final color when cured is the same as adjacent concrete.

3.3.3 Finishing Unformed Surfaces

3.3.3.1 Expansion and Contraction Joints

Provide [1/2 inch](#) thick transverse expansion joints where new work abuts an existing concrete. Provide expansion joints at a maximum spacing of [30 feet](#) on center in sidewalks, unless otherwise indicated. Provide contraction joints at a maximum spacing of [5 linear feet](#) in sidewalks,

unless otherwise indicated. Cut contraction joints at a minimum of 1 inch(es) deep with a jointing tool after the surface has been finished.

3.4 CURING AND PROTECTION

Cure and protect in accordance with ACI 301, Section 5.

3.5 FORM WORK

Provide form work in accordance with ACI 301, Section 2 and Section 5.

3.5.1 Removal of Forms

Remove forms in accordance with ACI 301, Section 2.

3.6 STEEL REINFORCING

Reinforcement must be free from loose, flaky rust and scale, and free from oil, grease, or other coating which might destroy or reduce the reinforcement's bond with the concrete.

3.6.1 Fabrication

Shop fabricate steel reinforcement in accordance with ACI 318 and ACI SP-66. Provide shop details and bending in accordance with ACI 318 and ACI SP-66.

3.6.2 Splicing

Perform splices in accordance with ACI 318 and ACI SP-66.

3.6.3 Supports

Secure reinforcement in place by the use of metal or concrete supports, spacers, or ties.

3.7 EMBEDDED ITEMS

Before placing concrete, take care to determine that all embedded items are firmly and securely fastened in place. Provide embedded items free of oil and other foreign matter, such as loose coatings of rust, paint and scale. Embedding of wood in concrete is permitted only when specifically authorized or directed.

3.8 TESTING AND INSPECTING

Report the results of all tests and inspections conducted at the project site informally at the end of each shift. Submit written reports weekly. Deliver within three days after the end of each weekly reporting period. See Section 01 45 00.00 20 QUALITY CONTROL.

3.8.1 Field Testing Technicians

The individuals who sample and test concrete must have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I.

3.8.2 Preparations for Placing

Inspect foundation or construction joints, forms, and embedded items in sufficient time prior to each concrete placement to certify that it is ready to receive concrete.

3.8.3 Sampling and Testing

- a. Obtain samples and test concrete for quality control during placement. Sample fresh concrete for testing in accordance with [ASTM C172/C172M](#). Make six test cylinders.
- b. Test concrete for compressive strength at 7 and 28 days for each design mix and for every [100 cubic yards](#) of concrete. Test two cylinders at 7 days; two cylinders at 28 days; and hold two cylinders in reserve. Conform test specimens to [ASTM C31/C31M](#). Perform [compressive strength testing](#) conforming to [ASTM C39/C39M](#).
- c. Test [slump](#) at the site of discharge for each design mix in accordance with [ASTM C143/C143M](#). Check slump twice during each shift that concrete is produced for each strength of concrete required.
- d. Test [air content](#) for air-entrained concrete in accordance with [ASTM C231/C231M](#). Test concrete using lightweight or extremely porous aggregates in accordance with [ASTM C173/C173M](#). Check air content at least twice during each shift that concrete is placed for each strength of concrete required.
- e. Determine temperature of concrete at time of placement in accordance with [ASTM C1064/C1064M](#). Check concrete temperature at least twice during each shift that concrete is placed for each strength of concrete required.

3.8.4 Action Required

3.8.4.1 Placing

Do not begin placement until the availability of an adequate number of acceptable vibrators, which are in working order and have competent operators, has been verified. Discontinue placing if any lift is inadequately consolidated.

3.8.4.2 Air Content

Whenever an air content test result is outside the specification limits, adjust the dosage of the air-entrainment admixture prior to delivery of concrete to forms.

3.8.4.3 Slump

Whenever a slump test result is outside the specification limits, adjust the batch weights of water and fine aggregate prior to delivery of concrete to the forms. Make the adjustments so that the water-cementitious material ratio does not exceed that specified in the submitted concrete mixture proportion and the required concrete strength is still met.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 45 00

PRECAST ARCHITECTURAL CONCRETE
05/16, CHG 2: 11/21

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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 251 (2006; R 2011) Standard Specification for Plain and Laminated Elastomeric Bridge Bearings

AMERICAN CONCRETE INSTITUTE (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 214R (2011) Evaluation of Strength Test Results of Concrete

ACI 301 (2016) Specifications for Structural Concrete

ACI 304R (2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete

ACI 305R (2020) 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)

ACI SP-66 (2004) ACI Detailing Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16 (2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP (2019; Errata 1 2019; Errata 2-5 2020;
Addenda BY-CP 2020; Addenda AF-DB 2020;
Addenda A-G 2020; Addenda F-Y 2021;
Errata 6-8 2021; Interpretation 1-4 2020;
Interpretation 5-8 2021 Addenda AS-AQ
2022) Energy Standard for Buildings Except
Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.21.1 (2009; R 2016) Washers: Helical
Spring-Lock, Tooth Lock, and Plain Washers
(Inch Series)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding
Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M (2020) Standard Specification for Steel
Castings, Carbon, for General Application

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 A153/A153M (2016a) Standard Specification for Zinc
Coating (Hot-Dip) on Iron and Steel
Hardware

ASTM A283/A283M (2013) Standard Specification for Low and
Intermediate Tensile Strength Carbon Steel
Plates

ASTM A449 (2014; R 2020) Standard Specification for
Hex Cap Screws, Bolts, and Studs, Steel,
Heat Treated, 120/105/90 ksi Minimum
Tensile Strength, General Use

ASTM A563 (2015) Standard Specification for Carbon
and Alloy Steel Nuts

ASTM A615/A615M (2022) Standard Specification for Deformed
and Plain Carbon-Steel Bars for Concrete
Reinforcement

ASTM A706/A706M (2022) Standard Specification for
Low-Alloy Steel Deformed and Plain Bars
for Concrete Reinforcement

ASTM A996/A996M (2016) Standard Specification for

Rail-Steel and Axle-Steel Deformed Bars
for Concrete Reinforcement

ASTM A1064/A1064M	(2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2022) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2021) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94/C94M	(2022a) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2022) 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 C311/C311M	(2022) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494/C494M	(2019; E 2022) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2021) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2022) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C979/C979M	(2016) Standard Specification for Pigments for Integrally Colored Concrete
ASTM C989/C989M	(2022) Standard Specification for Slag

Cement for Use in Concrete and Mortars

ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1157/C1157M	(2020a) Standard Performance Specification for Hydraulic Cement
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D746	(2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1149	(2007; R 2012) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D5759	(2012; R 2020) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-117	(2013) Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products, 3rd Edition
PCI MNL-122	(2007) Architectural Precast Concrete, 3rd Edition

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Installation Meeting

SD-02 Shop Drawings

Precast Drawings; G

SD-03 Product Data

Cast-In Embedded Items And Connectors; G

Connection Devices; G

Admixtures

Gasket

Bearing Pads

SD-04 Samples

Concrete Wall Panel Surface Finish; G

Mock-up

SD-05 Design Data

Design Calculations; G

Contractor-Furnished Mix Design; G

Concrete Mix Design for Repair of Surface Defects; G

Thermal Calculations; G

SD-06 Test Reports

Strength Tests; G

Slump

Air Content

Test for Concrete Materials

Water

Testing Precast Units for Strength

SD-07 Certificates

Manufacturer's Qualifications; G

Fabricator Quality Certifications

Erector Certification

Erector's Post Audit Declaration

SD-08 Manufacturer's Instructions

Installation; G

Cleaning; G

SD-11 Closeout Submittals

Concrete Batch Ticket Information; G

Recycled Content for Fly Ash and Pozzolan; S

Recycled Content for Ground Iron Blast-Furnace Slag; S

Recycled Content for Silica Fume; S

1.3 MODIFICATION OF REFERENCES

In the referenced ACI and PCI publications, consider the advisory provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.4 GENERAL REQUIREMENTS

Precast concrete units must be designed and fabricated by an experienced and certified precast concrete manufacturer. The manufacturer needs to have been regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings for at least 3 years. The Contractor must submit a statement detailing the Manufacturer's Qualifications. Coordinate precast work with the work of other trades.

1.5 DESIGN

1.5.1 Standards and Loads

Precast unit design must conform to ASCE 7-16, ACI 318 and PCI MNL-122. Indicate design loads for precast concrete on the drawings. A differential temperature of 192 degrees F, between interior and exterior faces of the units, must be considered in the design. Stresses due to restrained volume change caused by shrinkage and temperature differential, handling, transportation and erection must be accounted for in the design.

1.5.2 Connections

Connection of units to other members, or to other units must be of the type and configuration indicated. The design and sizing of connections for all design loads will be completed by the Contractor.

1.5.3 Concrete Proportion

Base the 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 proportion using the same type and brand of cement, 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 and admixtures containing chloride ions, nitrates, or other substances that are corrosive will not be used in prestressed concrete.

1.5.4 Design Calculations

Calculations for design of members, connections and embedments not shown must be made by a registered professional engineer experienced in the design of precast architectural concrete. Calculation will include the analysis of member for lifting stresses and the sizing of the lifting inserts. Submit calculations for review and approval prior to fabrication, signed and sealed by the registered design professional who prepared the design.

1.5.5 Thermal Calculations

Submit thermal calculations prepared and sealed by a registered professional engineer for review complying with [ASHRAE 90.1 - IP](#), for the steady state thermal resistance for the precast concrete wall panels. Thermal calculations must demonstrate the thermal conductivity of all components, the spacing of all connectors, the percent area of the wall that is solid concrete, and the thermal resistance of all components.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials, except for wall panels, to the project site in the original, unbroken packages or containers, each bearing a label clearly identifying manufacturer's name, brand 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.

Store products in manufacturer's unopened packaging in dry storage area, with ambient temperature between [30 degrees F](#) and [120 degrees F](#), until installation.

1.7 STORAGE AND INSPECTION AT MANUFACTURER'S PLANT

Protect precast units temporarily stored at the manufacturer's plant from damage in accordance with [PCI MNL-117](#) and [PCI MNL-122](#). Immediately prior to shipment to the jobsite, all precast concrete units must be inspected for quality to insure all precast units conform to the requirements specified. Inspection for quality will include, but will not be limited to, the following elements: color, texture, dimensional tolerances, chipping, cracking, staining, warping and honeycombing. Replace or repair all defective precast concrete units as approved.

1.8 PLANT INSPECTION

The Contractor is to 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.

1.8.1 Fabricator Quality Certifications

Plants must be certified by the PCI Plant Certification Program for Group A, Category A1, or Architectural Precast Association (APA) certification or National Precast Concrete Association (NPCA). When plants are not currently enrolled in one of the three certification programs listed above then they must provide a product quality control system in accordance with [PCI MNL-117](#) and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory.

1.9 ERECTOR CERTIFICATION

Erector with erecting organization and all erecting crews certified and designated by PCI's Certificate of Compliance to erect Category S2 (Complex Structural Systems) for load-bearing members.

1.10 ERECTOR QUALIFICATIONS

A precast erector that is not certified by PCI who retains a PCI-Certified Field Auditor, at the erector's expense, to conduct a field audit of a project in the same category as this project prior to start of precast concrete erection and must submit the [Erector's Post Audit Declaration](#) to be considered qualified.

1.11 CONCRETE SAMPLING AND TESTING

1.11.1 Test for Concrete Materials

Sample and test concrete materials proposed for use in the work in accordance with [PCI MNL-117](#).

Submit reports for each material sampled and tested prior to the start of work. Reports must contain the project name and number, date, name of Contractor, name of precast unit manufacturer, name of concrete testing service, source of concrete aggregates, generic name of aggregate, and values specified.

1.11.2 Quality Control Testing During Fabrication

Sample and test concrete for quality control during fabrication as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Sampling fresh concrete	ASTM C172/C172M except modified for slump per ASTM C94/C94M	As required for each test
Slump test	ASTM C143/C143M	One for each concrete load at point of discharge and one for each set of compressive strength tests
Air Content by pressure method	ASTM C231/C231M	One for each set of compressive strength tests

<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
Compressive test specimens	ASTM C31/C31M	One set of six specimens for each Compressive Strength test, one set per day or for every 20 cubic yards of concrete placed, whichever is greater.

Compression test specimens may be either standard 6 by 12 inch cylinders or 4-inch cubes. Cubes may be molded individually or cut from slabs. Preparation and testing of cube specimens must be as nearly consistent with the test methods specified as possible, with the exception that the concrete will be placed in a single layer.

Curing of compression test specimens must be the same as the curing method used for the precast concrete wall panels until panels are stripped of forms and then standard moist cure will continue.

<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
Concrete temperature		Each time a set of compression test specimens is made
Compressive strength tests	ASTM C39/C39M	One set of facing strength tests mix and one set of backing mix for every ten panels or fraction thereof cast in any one day; two specimens in each set tested at 7 calendar days; three specimens in each set tested at 28 calendar days, and one specimen in each set retained in reserve for testing if required

Evaluate compression test results at 28 days in accordance with ACI 214R using a coefficient of variation of 20 percent. Evaluate the strength of concrete by averaging the test results (two specimens) of standard cylinders tested at 28 days. Not more than 20 percent of the individual tests can have an average compressive strength less than the specified ultimate compressive strength. Submit test reports on the same day that tests are made.

Reports for Compressive Strength tests need to contain the project name and number, date of concrete placement, name of Contractor, name of precast concrete wall panel manufacturer, name of concrete testing service, panel identification letter and number, use of concrete mixture

(facing or backing), design compressive strength at 28 calendar days, concrete-mix proportions and materials, and compressive breaking strength and type of break.

If 4-inch cubes are used for compressive strength specimens, average strength of the cubes at any test age must be multiplied by the factor of 0.8 to arrive at an estimate of the corresponding 6 by 12 inch cylinder strength. Report both of these values .

1.12 QUALITY ASSURANCE

1.12.1 Precast Drawings

Submit precast drawings with the following information:

- a. Precast dimensions, cross-section, and edge details; location, size, and type of reinforcement, including reinforcement necessary for safe handling and erection of precast units and other embedded items. Comply with ACI SP-66.
- b. Layout, dimensions, and identification of each precast unit, 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 panels, and connection details to building framing system.

1.12.2 Concrete Wall Panel Surface Finish Sample

Submit a concrete wall panel sample 12 inches by 12 inches by approximately 1 1/2 inches in thickness, to illustrate quality, color, and texture of both exposed-to-view surface finish and finish of panel surfaces that will be concealed by other construction. Obtain approval prior to submission of sample panels.

Precast concrete surface finish is a split face texture that is white in color as indicated in Marine Corps Base Camp Lejeune Base Exterior Architectural Plan, Rifle Range Historic Area. Point joints with white mortar.

1.12.3 Required Records

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.12.4 Mock-Up

Provide mock-up to establish that proposed materials and construction techniques provide acceptable visual effect. Materials used for mock-up should be those proposed for actual construction. Include all anchors, connections, flashing and joint fillers. Apply specified products to determine acceptability of appearance and optimum coverage rate required for application

Provide mock-up sections of building and structures which typify the most difficult areas to build.

- a. Finish areas designated by Contracting Officer.
- b. Apply water repellent in accordance with manufacturer's instructions.
- c. After materials have cured, water test surface to determine that sufficient water repellent has been applied.
- d. Do not proceed with remaining work until workmanship, color, and detail are approved by Contracting Officer.
- e. Modify mock-up area as required to produce acceptable work.

Job Mock Up Panel: Minimum 4 feet by 4 feet

- a. Incorporate edge, reveal as shown on drawings.
- c. Show clean, pressure washed concrete surface.
- d. Utilize designated color of concrete mortar joints.
- e. Maintain Mock Up for comparison with finished work.

After approval by Contracting Officer, transport mock-up to job-site and erect where directed by Contracting Officer.

1.12.5 Pre-Installation Meeting

Hold a meeting at the job site with representative of the manufacturer and the applicator prior to application of water repellents and all other trades that may be effected by work of this section. Notify the Contracting Officer at least 3 days in advance of the time of the meeting.

1.13 TOLERANCES

Dimensions of the finished panel, at the time of erection in the structure, must conform to the tolerances for precast, non-prestressed elements in PCI MNL-117, unless otherwise specified by the Architect.

PART 2 PRODUCTS

2.1 CONCRETE

2.1.1 Contractor-Furnished Mix Design

ACI 211.1 and ACI 301. The Contractor must submit the mix design report giving the maximum nominal coarse aggregate size, the proportions of all ingredients and the type and amount of any admixtures that will be used in the manufacture of each strength and type of concrete, a minimum of sixty days prior to commencing operations. 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. Plot a curve for each concrete mixture, showing the relationships between water-cementitious material ratios and compressive strengths. Maximum permissible water-cementitious material ratio must be that value not exceeding the maximum water-cementitious material ratio specified, indicated by the curve to produce a design minimum laboratory compressive strength at 28 calendar days not less than that specified. The mix design report is to contain the project name and number, date, name of Contractor, name of precast concrete wall panel

manufacturer, name of concrete testing service, use of concrete mixture (facing or backing), source of concrete aggregates for each mixture. Submit certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, and aggregates. The statement must be accompanied by test results from an approved testing laboratory, certifying that the proportions selected will produce concrete of the properties required. Make no substitutions without additional tests to verify that the concrete properties are satisfactory. Concrete must have a 28-day compressive strength of 4000 psi. Air content of plastic concrete must be between 4 and 6 percent air by volume.

If, the compressive strength falls below that specified, adjust the mix proportions and water content and make necessary changes in the temperature, moisture, and curing procedures to secure the specified strength. Notify the Contracting Officer of all changes.

2.1.2 Exposed-to-View Facing Mixture

Provide aggregates for exposed-to-view facing mixture; white portland cement or a blend of two or more portland cements; and water. Provide exact proportions of facing mixture to produce concrete having the specified properties and capable of obtaining the approved surface color and finish.

2.1.3 Backing Mixture

Provide the approved mix design.

2.2 MATERIALS

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 AND REPORTING:

- a. Recycled content for fly ash and pozzolan
- b. Recycled content for Ground Iron Blast-Furnace Slag
- c. Recycled content for Silica Fume

2.2.2 Fine Aggregates

ASTM C33/C33M. The optional method of reducing the No. 50 and No. 100 sieve aggregates does not apply. The restriction to use only fine aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply.

2.2.3 Coarse Aggregate

ASTM C33/C33M, Size No. 67, Class 5S. The restriction to use only coarse aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply. Aggregate must not contain slag or crushed concrete.

2.2.4 Cementitious Materials

For exposed concrete, use one manufacturer and one source for each type of cement, ground slag, fly ash, and pozzolan.

2.2.4.1 Fly Ash

ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed 6 percent.

Add with cement. 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 permissible 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.

2.2.4.2 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirement for uniformity.

2.2.4.3 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.
- c. The sum of SiO₂ + Al₂O₃ + Fe₂O₃ must be greater than 77 percent.

2.2.4.4 Ground Granulated Blast-Furnace Slag

ASTM C989/C989M, Grade 100. Slag content must be a minimum of 25 percent by weight of cementitious material.

2.2.4.5 Portland Cement

Provide cement that conforms to ASTM C150/C150M, Type I, with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali content of 0.80 percent Na₂O_e (sodium oxide) equivalent. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch. Supplier must certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants are discharged.

2.2.4.6 Blended Cements

- a. Blended cements must conform to ASTM C595/C595M Type IP or ASTM C1157/C1157M Type GU .
- b. Slag cement added to the Type IS blend must meet ASTM C989/C989M.

- c. The pozzolan added to the Type IP blend must be **ASTM C618** Class F, and must be interground with the cement clinker. The manufacturer must state in writing that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. The percentage and type of pozzolan used in the blend must not change from that submitted for the aggregate evaluation and mixture proportioning.

2.2.5 Admixtures

ASTM C260/C260M for air-entraining admixtures. Other admixtures: **ASTM C494/C494M**. Certify that admixtures are free of chlorides. Coloring Admixture: **ASTM C979/C979M**, synthetic or natural mineral oxide or colored water reducing admixtures, temperature stable, and non-fading. Certify that coloring admixtures are free of chlorides.

2.2.6 Water

Water must comply with the requirements of **ASTM C1602/C1602M**. Minimize the amount of water in the mix. Improve workability by adjusting the grading rather than by adding water. Water must be potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete. Submit test report showing water complies with **ASTM C1602/C1602M**.

2.2.7 Reinforcement

All exposed steel must be phosphate treated, primed, and coated to prevent rust.

2.2.7.1 Reinforcing Bars

ACI 301 unless otherwise specified. **ASTM A615/A615M**, Grade 60, **ASTM A706/A706M**, Grade 60, or **ASTM A996/A996M**, Grade 40, or **ASTM A996/A996M**, Grade 60.

2.2.7.2 Welded Wire Reinforcement

ASTM A1064/A1064M.

2.2.7.3 Supports for Concrete Reinforcement

Include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening in place in accordance with **PCI MNL-117**.

2.2.8 Tie Wire

Tie wire must be soft monel or 18-8 stainless steel.

2.2.9 Plates, Angles, Anchors and Embedment

ASTM A36/A36M, ferrous metal plate connectors for attachment to the structural framing using manufacturer standard construction procedures. Headed studs will use 60,000 psi steel with construction conforming to **AWS D1.1/D1.1M**, Type B. Deformed bar anchors must conform to **ASTM A1064/A1064M**. Coat steel items, other than stainless, with a rust-inhibiting paint or provide hot-dip galvanized after fabrication in accordance with **ASTM A153/A153M**.

Furnish and install anchors, inserts, lifting devices, and other accessories which are to be embedded in the precast units in accordance with the approved detail drawings. Embedded items must be accurately positioned in their designed location, and have sufficient anchorage and embedment to satisfy design requirements.

2.2.10 Form Release Agent

Release agent must be manufacturer's standard non-staining type.

2.2.11 Grout

Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with [ASTM C1107/C1107M](#) and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to [ASTM C1218/C1218M](#).

2.3 CAST-IN EMBEDDED ITEMS AND CONNECTORS

2.3.1 Inserts

2.3.1.1 Threaded-Type Concrete Inserts

[ASTM A47/A47M](#), Grade 32510 or 35018, or may be medium strength cast steel conforming to [ASTM A27/A27M](#), Grade U-60-30. Provide galvanized ferrous casting having enlarged base with two nailing lugs minimum length less than the thickness of panel less [3/4 inch](#), and internally threaded to receive [3/4 inch](#) diameter machine bolt. Ferrous castings must be ferritic malleable iron. Provide inserts hot-dip galvanized after fabrication in accordance with [ASTM A153/A153M](#).

2.3.1.2 Wedge-Type Concrete Inserts

Provide galvanized, box-type ferrous castings with integral anchor loop at back of box to accept [3/4 inch](#) diameter bolts having special wedge-shaped head. Provide ferrous castings [ASTM A47/A47M](#), Grade 32510 or 35018, ferritic malleable iron or [ASTM A27/A27M](#), Grade U-60-30, medium-strength cast steel. Provide inserts hot-dip galvanized after fabrication in accordance with [ASTM A153/A153M](#).

2.3.1.3 Slotted-Type Concrete Inserts

Provide pressed steel plate, welded construction, box type with slot to receive [3/4 inch diameter](#) square head bolt, and provide lateral adjustment of bolt. Length of insert body, less anchorage lugs, must be [4 1/2 inches](#) minimum. Provide insert with knockout cover. Steel plate must be [1/8 inch](#) minimum thickness, [ASTM A283/A283M](#), Grade C. Provide inserts hot-dip galvanized after fabrication in accordance with [ASTM A153/A153M](#).

2.3.2 Connection Devices

2.3.2.1 Clip Angles

[ASTM A36/A36M](#) steel, galvanized after fabrication in accordance with [ASTM A153/A153M](#).

2.3.2.2 Ferrous Casting Clamps

ASTM A47/A47M, Grade 32510 or Grade 35018 malleable iron or cast steel, or ASTM A27/A27M, Grade 60-30, cast steel casting, hot-dip galvanized in accordance with ASTM A153/A153M.

2.3.2.3 Threaded Fasteners

Provide galvanized machine bolts, washers and, when required, nuts.

- a. Bolts: ASTM A449, 3/4 inch diameter machine bolts with hexagon head.
- b. Washers: ASME B18.21.1, medium or heavy lock-spring washers.
- c. Nuts: ASTM A563, Grade C, heavy, hexagon-type nuts.
- d. Square Nuts: ASTM A563, Grade A, plain, square-type nuts where required for slotted-type concrete inserts.

2.4 PRECAST ELEMENT FABRICATION

2.4.1 Formwork and Fabrication Tolerances

Provide forms and form-facing materials of wood, metal, plastic, or other approved material to produce concrete having the specified finish. Construct forms mortar-tight and of sufficient strength to withstand all pressures due to concrete placing operations and temperature changes. Brace and stiffen against deformation. Provide form liners where required to produce indicated finish. Provide dimensional tolerances per PCI MNL-117.

2.4.2 Reinforcement

ACI 301. Place reinforcing bars and welded wire reinforcement. Secure in position with tie wires, bar supports, and spacers.

2.4.3 Preparation for Placing Concrete

Remove hardened concrete, excess form parting compound, standing water, ice, snow, or other deleterious substances from form interiors and reinforcement before concrete placement. Secure reinforcement and embedded items.

2.4.4 Concrete Mixing and Conveying

2.4.4.1 Batch Plant, Mixer, Mixing, and Measuring of Materials

ASTM C94/C94M.

2.4.4.2 Conveying

Prevent segregation and loss of materials.

2.4.5 Concrete Placing

ACI 304R. Deposit concrete in the forms continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the

precast concrete units. Place concrete at a constant temperature of between 50 and 90 degrees F throughout fabrication of each unit. Make temperature of forms or molds the same as or close to the concrete temperature. For hot or cold weather, use methods recommended by ACI 305R and ACI 306.1. Vibrate and consolidate concrete to prevent segregation and to produce a high-density concrete free of honeycomb and rock pockets. When specified, the exposed-to-view facing mixture is required to be a minimum thickness of 3/4 inches. Place backing mixture before facing mixture attains initial set.

2.4.6 Identification Markings

Permanently mark each precast unit to indicate pick-up points, location, orientation in the building, and date of casting. Identification markings need to correlate with approved detail drawings. Do not locate in exposed-to-view finished surfaces.

2.4.7 Finishing

2.4.7.1 Unformed Concealed Surfaces (Standard Smooth Finish)

Provide a trowel finish. Level surface with a straightedge, and strike off. After surface water has disappeared, float and trowel surface. Provide smooth finished surface, free of trowel marks, and uniform in texture and appearance.

2.4.7.2 Split Face Textured, Exposed-to-View Surfaces

Provide a split face textured finish to all exposed-to-view surfaces of panels, unless otherwise indicated. Provide a concrete surface having the texture imparted by a steel form or other approved smooth surfaces form-facing material.

2.4.7.3 Other Surfaces

Surfaces of precast units not exposed to view or not otherwise indicated to be finished are to be finished in accordance with ACI 301 for a Surface Finish of 1.0.

2.4.8 Curing

Provide moist or steam curing or curing compound. Do not remove precast units from forms; prevent moisture loss and maintain 50 degrees F minimum for at least 24 hours after finishing. Maintain precast units in a surface damp condition at 50 degrees F minimum until concrete has attained 75 percent minimum of the design compressive strength.

2.4.9 Repair of Surface Defects

Cut out defective areas to solid concrete, with edges of cuts perpendicular to the surface of the concrete, and clean thoroughly. Dampen area to be patched and brush-coat with nonshrink grout or bonding agent. Patch the surface in accordance with procedures previously submitted by the Contractor and approved by the Contracting Officer. Where exposed to view, the patches, when dry, needs to be indistinguishable from the surrounding surfaces.

2.4.9.1 Smooth, Concealed Surfaces

Acceptable defective area will be limited to holes left by rods and other temporary inserts, and to honeycomb or rock pockets of 1/4 inch diameter maximum. Remove fins and other projections on the surfaces.

2.4.9.2 Exposed-to-View Surfaces

The combined area of acceptable defective areas must not exceed 0.2 percent of the exposed-to-view surface area and will be limited to holes of 1/4 inch diameter maximum.

2.4.10 Stripping

Do not remove precast concrete units from forms until units develop sufficient strength to safely strip the formwork and to remove the precast concrete units from the forms to prevent damage to the units from overstress or chipping.

2.4.11 Built-In Anchorage Devices

Accurately position and securely anchor all anchorage devices. Openings in anchorage devices must be filled temporarily to prevent entry of concrete.

2.4.12 Lifting Devices

Lifting devices must be provided, and designed for a safety factor of 4, which includes 100 percent impact. Do not use brittle material.

2.4.13 Finishing for Formed Surfaces

Upon removal of forms, repair and patch defective areas. Where the finished surface will be exposed to view, the combined area of defective areas must not exceed 0.2 percent of the surface and will be limited to honeycomb or rock pockets not deep enough to expose the reinforcement. Where the finished surface will be concealed by other construction, defective areas are limited to holes left by the rods and other temporary inserts and honeycomb or rock pockets not deep enough to expose the reinforcement. Defective areas must be cut out to solid concrete, cleaned, and patched with grout. Where concrete surface will be exposed to view, the patches, when dry, must be indistinguishable from the surrounding surfaces.

2.5 JOINT MATERIALS

Gasket must be elastomeric material, premolded to cross section indicated.

Material must be a vulcanized closed-cell expanded chloroprene conforming to ASTM D1056, Grade No. 2A2, with the following additional properties:

- a. Brittleness temperature will be minus 40 degrees F when tested in accordance with ASTM D746.
- b. Flammability resistance needs to be self-extinguishing when tested in accordance with ASTM D635.
- c. Resistance to ozone must be "no cracks" after exposure of a sample, at 20 percent elongation, to an ozone concentration of 100 parts per

million of air by volume in air for 100 hours at 104 degrees F when tested in accordance with ASTM D1149.

2.6 BEARING PADS

Submit product data for all bearing pads being used.

2.6.1 Elastomeric

AASHTO M 251, for plain neoprene bearings.

2.6.2 Random-Oriented, Fiber-Reinforced Elastomeric Pads

Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer according to ASTM D2240. Capable of supporting a compressive stress of 3000 psi with no cracking, splitting or delaminating in the internal portion of the pad.

2.6.3 Cotton-Duck-Fabric-Reinforced Elastomeric Pads

Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer according to ASTM D2240. Conforming to Division II, Section 18.10.2 of AASHTO LRFD Bridge Design Specifications or Military Specification MIL-C-882E.

2.6.4 Frictionless Pads

Polytetrafluoroethylene (PTFE), glass-fiber reinforced, bonded to stainless or mild-steel plates, or random-oriented, fiber-reinforced elastomeric pads, of type required for in-service stress.

2.6.5 High-Density Plastic

Multimonomer, nonleaching, plastic strip capable of supporting loads with no visible overall expansion.

PART 3 EXECUTION

3.1 PREPARATION

Deliver anchorage devices to the site in time to be installed before the start of concrete placing or during steel erection. Contractor must provide setting drawings, instructions, and directions for the installation of anchorage devices.

3.2 EXAMINATION

Do not begin installation until supporting structures have been properly prepared.

Verify that all parts of the supporting structure are complete and ready to receive the precast units and that site conditions are conducive to proper installation.

If support structure is the responsibility of another installer, notify Contracting Officer of unsatisfactory preparation before proceeding.

3.3 INSTALLATION

Install precast concrete units and accessories in accordance with approved detail drawings and descriptive data, and as specified below.

3.3.1 Building Framing System

Provide supporting members, including anchorage items attached to or embedded in building structural elements, prior to placement of precast units.

3.3.2 Concrete Strength at Time of Precast Unit Installation

Do not install precast units until concrete has attained the minimum laboratory compressive strength at 28 calendar days specified.

3.3.3 Erection

Erect precast units in accordance with the detail drawings and without damage to other units or to adjacent members. Set units true to alignment and level, with joints properly spaced and aligned both vertically and horizontally. Erection tolerances must be in accordance with the requirements of [PCI MNL-117](#) and [PCI MNL-122](#). As units are being erected, shims and wedges will be placed as required to maintain correct alignment. After final attachment, grout precast units as shown. After erection, clean and touch-up welds and abraded surfaces of steel with a zinc-rich paint. Welds must be made by a certified welder in accordance with the manufacturer's erection drawings. Finish pickup points, boxouts, inserts, and similar items to match adjacent areas after erection. Erection of precast units must be supervised and performed by workmen skilled in this type of work. Welding and the qualifications of welders must be in accordance with [AWS D1.1/D1.1M](#).

3.3.4 Erection Tolerances

Erect architectural precast concrete units level, plumb, square and in alignment without exceeding the noncumulative erection tolerances of [PCI MNL-117](#), Appendix I.

3.3.5 Joints

Joint widths between precast units will be as specified unless otherwise indicated.

3.3.5.1 Joint Sealing

Joint sealing will be as specified in Section [07 92 00 JOINT SEALANTS](#).

3.3.6 Protection

Protect exposed-to-view facing from staining and other damage from subsequent operations. Do not allow laitance to penetrate, stain, or harden on exposed surfaces.

3.4 DEFECTIVE WORK

Repair precast concrete units damaged during erection as soon after occurrence as possible or replaced, as directed, using approved procedures. All repairs to precast concrete units must match the adjacent

surfaces in color and texture, as approved. Unless otherwise approved, repair procedures will conform to [PCI MNL-117](#).

3.5 JOINTS AND GASKETS

Joints between precast units must be the width indicated and within limits of installation tolerances.

Install gaskets in joints as indicated, continuous throughout the joint length, and compressed at least 25 percent by volume.

3.6 INSPECTION AND ACCEPTANCE PROVISIONS

3.6.1 Dimensional Tolerances

Precast units having dimensions outside the limits for fabrication tolerances will be rejected.

3.6.2 Surface Finish Requirements

Precast units will be rejected for the following surface finish deficiencies:

- a. Exposed-to-view surfaces that do not match the color, aggregate size and distribution, and texture of the approved sample
- b. Exposed-to-view surfaces that contain defects that affect the appearance of the finish, such as cracks, spalls, honeycomb, rock pockets, or stains and discoloration of aggregate or matrix that cannot be removed by cleaning
- c. Concealed surfaces that contain cracks in excess of [0.01 inch](#) wide, cracks that penetrate to the reinforcement regardless of width, honeycomb, rock pockets, and spalls except minor breakage at corners and edges

3.6.3 Strength of Precast Units

Strength of precast concrete units will be considered potentially deficient if the units fail to comply with the requirements that control the strength of the units, including the following conditions:

- a. Failure to meet compressive strength tests
- b. Reinforcement not conforming to the requirements specified
- c. Concrete curing and protection of precast units against extremes of temperature during curing not conforming to the requirements specified
- d. Precast units damaged during handling and erection

3.6.4 [Testing Precast Units for Strength](#)

When there is evidence that the strength of precast concrete units does not meet specification requirements, cores drilled from hardened concrete for compressive strength determination must be made in accordance with [ASTM C42/C42M](#) and as follows:

- a. Take at least three representative cores from the precast-concrete

units that are considered potentially deficient.

- b. Test cores with the saturated surface dry.
- c. Strength of cores will be considered satisfactory if their average is equal to or greater than 90 percent of the 28-day design compressive strength of 6 by 12 inch cylinders.

Submit test reports on the same day that tests are made. Reports must contain the project name and number, date, name of contractor, name of precast concrete wall units manufacturer, name of concrete-testing service, identification letter and number of units represented by core tests, nominal maximum size of aggregate, design compressive strength of concrete at 28 calendar days, compressive breaking strength and type of break, length of core test specimen before capping, compressive strength after correcting for length diameter ratio, direction of application of the load on the core test specimen with respect to the horizontal plane of the concrete as placed, and the moisture condition of the core test specimen at time of testing.

If the results of the core tests are unsatisfactory or if core tests are impractical to obtain, a static load tests of a precast unit will be evaluated in accordance with ACI 318.

Replace precast units used for core tests or static load tests with units that meet the requirements of this section.

3.7 SAMPLING AND TESTING

3.7.1 Rejection

Precast units in place 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. Air voids (bugholes or blowholes) larger than 3/8 inch diameter.
- c. Visible casting lines.
- d. Visible from joints.
- e. Visible irregularities.
- f. Visible stains on precast unit surfaces.
- g. Visible differences between precast unit and approved sample.
- h. Visible non-uniformity 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. Precast units that are damaged during construction operations.

3.7.2 Field Quality Control

Perform field inspection of precast unit connections. Notify the Contracting Officer in writing of defective welds, bolts, nuts and washers within 7 working days of the date of inspection. All defective connections or welds are to be removed and re-welded or repaired as required by the Contracting Officer.

3.7.2.1 Welded Connection Visual Inspection

AWS D1.1/D1.1M, furnish the services of AWS-certified welding inspector for erection inspections. Welding inspector must visually inspect all welds and identify all defective welds.

3.8 CLEANING

Clean exposed-to-view surfaces of precast 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 precast manufacturer. Surfaces must be clean and uniform in color. Include precast concrete wall panel manufacturer's written recommendations for installation and cleaning.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 04 20 00

UNIT MASONRY
11/15, CHG 2: 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.

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 A167 (2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ASTM A185/A185M (2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

ASTM A615/A615M (2022) 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 A653/A653M (2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

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 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 A1064/A1064M (2017) Standard Specification for

Carbon-Steel Wire and Welded Wire
Reinforcement, Plain and Deformed, for
Concrete

ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C67/C67M	(2021) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C90	(2021) Standard Specification for Loadbearing Concrete Masonry Units
ASTM C129	(2017) Standard Specification for Nonloadbearing Concrete Masonry Units
ASTM C207	(2018) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C216	(2021) Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
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; E 2022) Standard Specification for Chemical Admixtures for Concrete
ASTM C641	(2017) Standard Test Method for Iron Staining Materials in Lightweight Concrete Aggregates
ASTM C780	(2020) Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C979/C979M	(2016) Standard Specification for Pigments for Integrally Colored Concrete
ASTM C1019	(2019) Standard Test Method for Sampling and Testing Grout
ASTM C1314	(2014) Standard Test Method for Compressive Strength of Masonry Prisms
ASTM C1384	(2012a) Standard Specification for Admixtures for Masonry Mortars
ASTM C1611/C1611M	(2021) Standard Test Method for Slump Flow of Self-Consolidating Concrete

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcement Detail Drawings; G

SD-03 Product Data

Hot Weather Procedures; G

Cold Weather Procedures; G

Clay or Shale Brick; G

Insulation; G

SD-04 Samples

Mock-Up Panel; G

Clay or Shale Brick; G

Clay Masonry Expansion-Joint Materials; G

SD-05 Design Data

Masonry Compressive Strength; G

Bracing Calculations; G

SD-06 Test Reports

Efflorescence Test

Field Testing of Mortar

Field Testing of Grout

Prism Tests

SD-07 Certificates

Clay or Shale Brick

Concrete Masonry Units (CMU)

Cementitious Materials

Admixtures for Masonry Mortar

Admixtures for Grout

Anchors, Ties, and Bar Positioners

Joint Reinforcement

Insulation

SD-08 Manufacturer's Instructions

Admixtures for Masonry Mortar

Admixtures for Grout

SD-10 Operation and Maintenance Data

Take-Back Program

SD-11 Closeout Submittals

Recycled Content of Clay Units; S

Recycled Content of Cement; S

1.3 QUALITY ASSURANCE

1.3.1 Masonry Mock-Up Panels

1.3.1.1 Mock-Up Panel Location

After material samples are approved and prior to starting masonry work, construct a [mock-up panel](#) for each type and color of masonry required. At least 48 hours prior to constructing the panel or panels, submit written notification to the Contracting Officer. Do not build-in mock-up panels as part of the structure; locate mock-up panels where directed. Construct portable mock-up panels or locate in an area where they will not be disrupted during construction.

1.3.1.2 Mock-Up Panel Configuration

Construct mock-up panels L-shaped or otherwise configured to represent all of the wall elements. Construct panels of the size necessary to demonstrate the acceptable level of workmanship for each type of masonry represented on the project. Provide a straight panel or a leg of an L-shaped panel of minimum size [8 feet](#) long by [4 feet](#) high.

1.3.1.3 Mock-Up Panel Composition

Show full color range, texture, and bond pattern of the masonry work. Demonstrate mortar joint tooling; grouting of reinforced vertical cores, collar joints, bond beams, and lintels; positioning, securing, and lapping of reinforcing steel; positioning and lapping of joint reinforcement (including prefabricated corners); and cleaning of masonry work during the construction of the panels. Also include installation or application procedures for anchors, wall ties, [CMU control joints](#), [brick expansion joints](#), [insulation](#), flashing, [brick soldier](#), row lock courses and weeps.

Include a a bond beam corner. When the panel represents reinforced masonry, include a 2 by 2 foot opening placed at least 2 feet above the panel base and 2 feet away from all free edges, corners, and control joints. Provide required reinforcing around this opening as well as at wall corners and control joints.

1.3.1.4 Mock-Up Panel Construction Method

Where anchored veneer walls or cavity walls are required, demonstrate and receive approval for the method of construction; i.e., either bring up the two wythes together or separately, with the insulation and appropriate ties placed within the specified tolerances across the cavity. Demonstrate provisions to preclude mortar or grout droppings in the cavity and to provide a clear open air space of the dimensions shown on the drawings. Where masonry is to be grouted, demonstrate and receive approval on the method that will be used to bring up the masonry wythes; support the reinforcing bars; and grout cells, bond beams, lintels, and collar joints using the requirements specified herein. Construct panels on a properly designed concrete foundation.

1.3.1.5 Mock-Up Panel Purpose

The completed panels is used as the standard of workmanship for the type of masonry represented. Do not commence masonry work until the mock-up panel for that type of masonry construction has been completed and approved. Protect panels from the weather and construction operations until the masonry work has been completed and approved. Perform cleaning procedures on the mockup and obtain approval of the Contracting Officer prior to cleaning the building. After completion of the work, completely remove the mock-up panels, including all foundation concrete, from the construction site.

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.

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 1,500 PSI.

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 Clay or Shale Brick

2.2.2.1 General

2.2.2.1.1 Sample Submittal

Submit brick samples as specified, showing the color range and texture of clay or shale brick. Limit units used on the project to those that conform to the approved sample. Submit sample of colored mortar with applicable masonry unit and color samples of three stretcher units and one

unit for each type of special shape.

2.2.2.1.2 Uniformity

Manufacture bricks at one time and from the same run. Deliver clay or shale brick units factory-blended to provide a uniform appearance and color range in the completed wall.

2.2.2.1.3 Recycled Content

Provide **clay units** containing a minimum of 5 percent post-consumer recycled content, and a minimum of 20 percent post-industrial recycled content.

2.2.2.1.4 Efflorescence Test

Test clay brick that will be exposed to weathering for efflorescence in accordance with **ASTM C67/C67M**. Schedule tests far enough in advance of starting masonry work to permit retesting if necessary. Units meeting the definition of "effloresced" are subject to rejection.

2.2.2.2 Solid Clay or Shale Brick

Provide solid clay or shale brick that conforms to **ASTM C216**, Type FBA. Provide brick with minimum compressive strength of 3,000 **psi**. Where brick cores, recesses, or deformation would be exposed to view, provide 100 percent solid units. Brick is a red flash smooth modular as indicated in Marine Corps Base Camp Lejeune Base Exterior Architectural Plan, Rifle Range Historic Area. Mortar is light beige..

Provide brick with specified sizes.

- a. Modular size, 3-5/8 inches thick, 2-1/4 inches high, and 7-5/8 inches long.

2.2.3 Concrete Units

2.2.3.1 Aggregates

Test lightweight aggregates, and blends of lightweight and heavier aggregates in proportions used in producing the units, for stain-producing iron compounds in accordance with **ASTM C641**, visual classification method. Do not incorporate aggregates for which the iron stain deposited on the filter paper exceeds the "light stain" classification.

Use industrial waste by-products (air-cooled slag, cinders, or bottom ash), ground waste glass and concrete, granulated slag, and expanded slag in aggregates.

2.2.3.2 Concrete Masonry Units (CMU)

2.2.3.2.1 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.

2.2.3.2.2 Size

Provide units with specified dimension of 7.625 inches wide, 7.625 inches high, and 15.625 inches long. Provide a variety of standard wythe widths and shapees. Furnish bullnose, corner, double corner, sill, cap and header units. Furnish special shapes indicated in the Instruments of Service. Units must have a regular, consistent texture.

2.2.3.2.3 Surfaces

Provide units with exposed surfaces that are smooth and of uniform texture.

2.2.3.2.4 Unit Types

- a. Hollow Load-Bearing Units: ASTM C90, lightweight. Provide load-bearing units for exterior walls, foundation walls, load-bearing walls, and shear walls.
- b. Hollow Non-Load-Bearing Units: ASTM C129, lightweight. Load-bearing units may be provided in lieu of non-load-bearing units.
- c. Solid Load-Bearing Units: ASTM C90, lightweight units. Provide solid units as indicated.

2.2.3.2.5 Jamb Units

Provide jamb units of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved.

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 Colored Mortar

Use mortar pigment that conforms to ASTM C979/C979M. Add pigment to mortar to produce a uniform light beige color. Furnish pigments in

accurately pre-measured and packaged units that can be added to a measured amount of cementitious materials or supply pigments via preblended cementitious materials or dry mortar mix.

- a. In masonry cement or mortar cement, do not exceed 5 percent of cement weight for mineral oxide pigment; do not exceed 1 percent of cement weight for carbon black pigment.
- b. In cement-lime mortar mix, do not exceed 10 percent of cementitious materials' weight for mineral oxide pigment; do not exceed 2 percent of cementitious materials' weight for carbon black pigment.

2.4.1.4 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.

2.4.1.5 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. Do not use masonry cement in the mortar.
- b. 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.

2.5.2 Grout and Ready Mix Grout Mix

Use grout that conforms to [ASTM C476](#). 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 [3,000 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 anchors and ties without drips or crimps. Size anchors and ties to provide a minimum of [5/8 inch](#) mortar cover from each face of masonry.
- b. Fabricate steel wire anchors and ties from wire conforming to [ASTM A1064/A1064M](#) and hot-dip galvanize in accordance with [ASTM A153/A153M](#).
- c. 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.
- d. Fabricate sheet metal anchors and ties in conformance with [ASTM A1008/A1008M](#). Hot dip galvanize sheet metal anchors and ties in exterior walls and in interior walls exposed to moist environment in compliance with [ASTM A153/A153M](#) Class B. Galvanize sheet metal anchors and ties in other interior walls in compliance with [ASTM A653/A653M](#), Coating Designation G60.
- e. Submit two anchors, ties and bar positioners of each type used, as samples.

2.6.2.2 Wire Mesh Anchors

Provide wire mesh anchors of [1/4 inch](#) mesh galvanized hardware cloth, conforming to [ASTM A185/A185M](#), with length not less than [12 inches](#), at intersections of interior non-bearing masonry walls.

2.6.2.3 Wall Ties for Multi-Wythe Masonry Construction

Provide rectangular-shaped wall ties, fabricated of hot-dipped galvanized

W1.7 diameter steel wire. Provide rectangular wall ties no less than 4 inches wide.

Provide adjustable type wall ties, if approved for use, that consist of two essentially U-shaped elements fabricated of minimum W2.8 diameter steel wire or pintle type ties that are inserted to eyes of horizontal joint reinforcement, hot-dip galvanized. Provide adjustable ties with double pintle legs and allows a maximum offset of 1-1/4 inch between each element of the tie and maximum distance between connecting parts no more than 1/16 inch. Form the pintle and eye elements so that both can be in the same plane. Wall ties may also be of a continuous type conforming to paragraph JOINT REINFORCEMENT.

2.6.2.4 Adjustable Anchors

2.6.2.4.1 Anchorage to Structural Steel

Provide hot-dip galvanized adjustable anchors for connecting masonry walls to the structural steel frame at 1 foot, 4 inches inches on center. Provide zinc-rich paint for touching up paint after welding galvanized anchors to structural steel.

2.6.2.5 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

Provide reinforcing steel bars and rods conforming to ASTM A615/A615M or ASTM A996/A996M, Grade 60.

2.6.5 Clay Masonry Expansion-Joint Materials

Provide backer rod and sealant, adequate to accommodate joint compression and extension equal to 50 percent of the width of the joint. Provide the backer rod of compressible rod stock of closed cell polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive

material as recommended by the sealant manufacturer. Provide sealant in conformance with Section 07 92 00 JOINT SEALANTS with a maximum volatile organic compound (VOC) content of 600 grams/liter.

Submit one piece of each type of material used.

2.6.6 Through Wall Flashing and Weeps

2.6.6.1 General

Provide copper or stainless steel sheet, self-adhesive rubberized sheet, or reinforced membrane sheet flashing.

2.6.6.2 Copper or Stainless Steel Flashing

Provide copper sheet, complying with ASTM B370, minimum 16 ounce weight; or stainless steel, ASTM A167, Type 304 or 316, 0.015 inch thick, No. 2D finish.

2.6.6.3 Rubberized Flashing

Provide self-adhesive rubberized asphalt sheet flashing consisting of 32-mil thick pliable and highly adhesive rubberized asphalt compound bonded completely and integrally to 8-mil thick, high density, cross-laminated polyethylene film to produce an overall thickness of 40 mils. Provide rubberized, asphalt-based mastic and surface conditioner that are each approved by flashing manufacturer for use with flashing material.

2.6.6.4 Weep Ventilators

Provide weep ventilators that are prefabricated from stainless steel. Provide inserts with grill or louver-type openings designed to allow the passage of moisture from cavities and to prevent the entrance of insects, and with a rectangular closure strip to prevent mortar droppings from clogging the opening. Provide ventilators with compressible flanges to fit in a standard 3/8 inch wide mortar joint and with height equal to the nominal height of the unit.

2.6.6.5 Metal Drip Edge

Provide stainless steel drip edge, 15-mil thick, hemmed edges, with down-turned drip at the outside edge and upturned dam at the inside edge for use with membrane flashings.

2.6.7 RIGID BOARD-TYPE INSULATION

Provide rigid board-type insulation as specified in Section 07 21 13 BOARD AND BLOCK INSULATION.

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 the indicated bond patterns. Lay facing courses level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances is plus or minus $1/2$ inch. 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 air spaces, cavities, chases, 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.

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.

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. Tooothing 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 Clay Masonry Expansion Joints

Provide clay masonry expansion joints as indicated. Construct by filling with a compressible foam pad. Ensure that no mortar or other noncompressible materials are within the joint. Install backer rod and sealant in accordance with Section 07 92 00 JOINT SEALANTS.

3.3.1.5 Control Joints

Provide control joints in concrete masonry as indicated. Construct by raking out mortar within the head 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.

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 Clay or Shale Brick Masonry

3.3.2.1 Brick Placement

Blend all brick at the jobsite from several cubes to produce a uniform appearance when installed. An observable "banding" or "layering" of colors or textures caused by improperly mixed brick is unacceptable. Lay brick facing with the better face exposed. Lay brick in running bond with each course bonded at corners, unless otherwise indicated. Lay molded brick with the frog side down. Do not lay brick that is cored, recessed, or has other deformations in a manner that allows those deformations to be exposed to view; lay 100 percent solid units in these areas. Completely fill head and bed joints of solid units with mortar. Lay hollow units with mortar joints as specified for concrete masonry units.

3.3.2.2 Wetting of Units

Wet clay, shale brick, or hollow brick units having an initial rate of absorption of more than 1 gram per minute per square inch of bed surface in conformance with ASTM C67/C67M. Ensure that each unit is nearly saturated when wetted but surface dry when laid.

Test clay or shale brick daily on the job, prior to laying, as follows: Using a wax pencil, draw a circle the size of a quarter on five randomly selected bricks. Apply 20 drops of water with a medicine dropper to the surface within the circle on each brick. If the average time that the water is completely absorbed in the five bricks is less than 1-1/2 minutes, wet bricks represented by the five bricks tested.

3.3.2.3 Brick Sills

Lay brick on edge, slope not less than 3/4 inch downward to the outside, and project not less than 1/2 inch beyond the face of the wall to form a wash and drip. Fill all joints solidly with mortar and tool.

3.3.2.4 Partitions

- a. Construct partitions continuous from floor to underside of floor or roof deck where shown. Fill openings in firewalls around joists and other structural members as indicated or approved. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 4 inches above the ceiling level. Construct an isolation joint in the intersection between partitions and structural or exterior walls.
- b. Tie interior partitions having 4 inch nominal thickness units to intersecting partitions of 4 inch units, 5 inches into partitions of 6 inch units, and 7 inches into partitions of 8 inch or thicker units. Fill cells within vertical plane of ties solid with grout for full height of partition or solid masonry units may be used. Tie interior partitions over 4 inches thick together with joint reinforcement. Provide joint reinforcement with prefabricated pieces at corners and intersections of partitions.

3.3.3 Cavity Walls (Multi-Wythe Noncomposite Walls)

Provide a continuous cavity as indicated. Bevel mortar beds away from cavity to prevent projection into cavity when bricks are shoved in place. Keep cavities clear and clean of mortar droppings. At the bottom of cavity walls, in the course immediately above the through-wall flashing, temporarily omit one brick every 4 feet. Clean mortar droppings and debris out of the cavity through the temporary openings at least once each day masonry is laid, and more often when required to keep the cavities clean. Fill in the openings with bricks and mortar after the wall is complete and the cavity has been inspected and found clean.

Securely tie the two wythes together with horizontal joint reinforcement, or provide ties to connect the masonry wythes in sufficient quantity to comply with the following requirements: maximum wall area per tie of 2.67 square feet, and maximum vertical spacing of 2 feet, 0 inches, and maximum horizontal spacing of 1 foot, 4 inches. Provide additional ties around openings larger than 16 inches in either direction. Space ties around perimeter of opening at a maximum of 3 feet on center. Place ties within 12 inches of openings. Ties with drips are not permitted.

3.3.4 ANCHORAGE

3.3.4.1 Anchorage to Structural Steel

Anchor masonry to vertical structural steel framing with adjustable steel wire anchors spaced not over 16 inches on centers vertically, and if applicable, not over 24 inches on centers horizontally.

3.3.4.2 Anchorage at Intersecting Walls

Provide wire mesh anchors at maximum 16 inches spacing at intersections of interior non-bearing masonry walls.

Anchor structural masonry walls with horizontal joint reinforcement spaced no more than 1 foot, 4 inches feet on center, unless the drawings indicate a movement joint at the intersection.

3.3.5 Lintels

3.3.5.1 Masonry Lintels

Construct masonry lintels with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated. Extend lintel reinforcement beyond each side of masonry opening 40 bar diameters or 24 inches, whichever is greater. Support reinforcing bars in place prior to grouting and locate 1/2 inch above the bottom inside surface of the lintel unit.

3.3.6 Sills

Set sills in a full bed of mortar with faces plumb and true. Slope sills to drain water. Mechanically anchor sills.

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. Maintain a minimum clearance of 1/2 inch 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.

- b. 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.

3.4.2 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 Grout 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. Provide cleanout holes at a maximum spacing of 32 inches where all cells are to be filled with grout.

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.

3.4.2.3.2 Cleanouts for Multi-Wythe Composite Masonry Construction

Provide cleanouts for construction of walls that incorporate a grout

filled cavity between solid masonry wythes, provide cleanouts at the bottom of every pour by omitting every other masonry unit from one wythe. Establish a new series of cleanouts if grouting operations are stopped for more than 4 hours. Do not plug 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 cleanouts in accordance with paragraph GROUT 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 or expansion joints, unless otherwise indicated.

3.4.5 Flashing and Weeps

- a. Install through-wall flashing at obstructions in the cavity and where indicated on Drawings. Ensure continuity of the flashing at laps and inside and outside corners by splicing in a manner approved by the flashing manufacturer. Ensure that the top edge of the flashing is sealed by turning metal flashing 1/2 inch into the mortar bed joint of backup masonry and by attaching a termination bar and applying compatible sealant at the top edge of the termination bar for rubberized flashing. Terminate the horizontal leg of the flashing terminating the fabric flashing 1/2 inch short of the outside face of masonry and adhering the flashing to a sheet metal drip edge. Provide sealant below the drip edge of through-wall flashing.
- b. Wherever through-wall flashing occurs, provide weep holes to drain flashing to exterior at acceptable locations as indicated. Provide weeps of weep ventilators. Locate weeps not more than 24 inches on centers in mortar joints of the exterior wythe directly on the horizontal leg of through-wall flashing over foundations, bond beams, and any other horizontal interruptions of the cavity. Place weep holes perfectly horizontal or slightly canted downward to encourage water drainage outward and not inward. Other methods may be used for providing weeps when spacing is reduced to 16 inches on center and approved by the Contracting Officer. Maintain weeps free of mortar and other obstructions.

3.5 APPLICATION

3.5.1 Insulation

Insulate cavity walls (multi-wythe noncomposite masonry walls), where shown, by installing board-type insulation on the cavity side of the inner wythe. Apply board type insulation directly to the masonry or thru-wall

flashing with adhesive. Neatly fit insulation between obstructions without impaling insulation on ties or anchors. Apply insulation in parallel courses with vertical joints breaking midway over the course below and in moderate contact with adjoining units without forcing. Cut to fit neatly against adjoining surfaces.

3.5.2 Interface with Other Products

3.5.2.1 Built-In Items

Fill spaces around built-in items with mortar. Point openings around flush-mount electrical outlet boxes in wet locations with mortar. Embed anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in as the masonry work progresses. Fully embed anchors, ties and joint reinforcement in the mortar. Fill cells receiving anchor bolts and cells of the first course below bearing plates with grout, unless otherwise indicated.

3.5.2.2 Bearing Plates

Set bearing plates for beams, joists, joist girders and similar structural members to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Provide bedding mortar and non-shrink grout.

3.5.3 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

Prepare and test mortar samples for mortar aggregate ratio in accordance with [ASTM C780](#) Appendix A4.

3.6.1.2 Field Testing of Grout

- a. Perform grout testing. For each required grout property to be evaluated, provide a minimum of three specimens.
- b. Sample and test conventional and self-consolidating 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](#).

3.6.1.3 Clay Brick Efflorescence Test

Test clay brick that will be exposed to weathering for efflorescence in accordance with [ASTM C67/C67M](#). Schedule tests far enough in advance of starting masonry work to permit retesting if necessary. Units meeting the definition of "effloresced" are subject to rejection.

3.6.1.4 Prism Tests

Perform prism testing in lieu of grout testing where masonry compressive strengths required are higher than the values derived from the unit strength method. Evaluate three prisms in each test. Fabricate, store, handle, and test prisms in accordance with ASTM C1314.

Seven-day tests may be used provided the relationship between the 7- and 28-day strengths of the masonry is established by the tests of the materials used. If the compressive strength of any prism falls below the specified value by more than 500 psi, take steps to assure that the load-carrying capacity of the structure is not jeopardized. If the likelihood of low-strength masonry is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled, or prisms sawed, from the area in question may be required. In such case, take three specimens for each prism test more than 500 psi below the specified value. Masonry in the area in question will be considered structurally adequate if the average compressive strength of three specimens is equal to or exceeds the specified value. Additional testing of specimens extracted from locations represented by erratic core or prism strength test results will be permitted.

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. Before completion of the work, rake out defects in joints of masonry to be exposed, 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.

3.7.2 Clay Brick Surfaces

Clean exposed clay brick masonry surfaces to obtain surfaces free of stain, dirt, mortar and grout daubs, efflorescence, and discoloration or scum from cleaning operations. Perform cleaning in accordance with the approved cleaning procedure demonstrated on the mockup.

After cleaning, examine the sample panel of similar material for discoloration or stain as a result of cleaning. If the sample panel is discolored or stained, change the method of cleaning to ensure that the masonry surfaces in the structure will not be adversely affected. Water-soak exposed masonry surfaces and then clean with a proprietary masonry cleaning agent specifically recommended for the color and texture by the clay brick manufacturer and manufacturer of the cleaning product. Apply the solution with stiff fiber brushes, followed immediately by thorough rinsing with clean water. Use proprietary cleaning agents in conformance with the cleaning product manufacturer's printed

recommendations. Remove efflorescence in conformance with the brick manufacturer's recommendations.

3.8 CLOSE-OUT TAKE-BACK PROGRAM

Collect information from manufacturer for take-back program options. Set aside 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. 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 05 12 00

STRUCTURAL STEEL
08/18, CHG 2: 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 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 SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel
------------------	--

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay
------------	---

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M	(2021) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A29/A29M	(2020) Standard Specification for General Requirements for Steel Bars, Carbon and

Alloy, Hot-Wrought

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) 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 A143/A143M	(2007; R 2020) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2021a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992/A992M	(2020) Standard Specification for Structural Steel Shapes
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C827/C827M	(2016) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F436/F436M	(2019) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F844	(2019) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F959/F959M	(2017a) Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural

Fasteners, Inch and Metric Series

ASTM F1136/F1136M	(2011) Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F2329/F2329M	(2015) Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
ASTM F2833	(2011; R 2017) Standard Specification for Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2020) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes
---------	--

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC Paint 20	(2019) 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	(2018) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2019, with Change 1, 2022) Structural Engineering
--------------	--

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR Part 1926, Subpart R	Steel Erection
-----------------------------	----------------

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Erection and Erection Bracing Drawings; G

SD-02 Shop Drawings

Fabrication Drawings Including Details of Connections; G

SD-03 Product Data

Shop Primer

Welding Electrodes and Rods

Direct Tension Indicator Washers

Non-Shrink Grout

Tension Control Bolts

Recycled Content for Structural Steel; S

Recycled Content for Structural Steel Tubing; S

Recycled Content for Steel Pipe; S

SD-05 Design Data

Design Calculations for Steel Connections; G

SD-06 Test Reports

Class B Coating

Bolts, Nuts, and Washers

Weld Inspection Reports

Direct Tension Indicator Washer Inspection Reports

Bolt Testing Reports

Embrittlement Test Reports

SD-07 Certificates

Steel

Bolts, Nuts, and Washers

Galvanizing

Welding Procedures and Qualifications

Welding Electrodes and Rods

Certified Welding Inspector

NDT Technician

Welding Procedure Specifications (WPS)

Overhead, Top Running Crane Rail Beam

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**. Erection drawings must be reviewed, stamped and sealed by a registered professional engineer.

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. Sign and seal fabrication drawings by a registered professional engineer. 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 Delegated Connection Design

Design structural steel connection indicated in the contract documents per **AISC 303**, Option 3, using the connection loads indicated. Submit **design calculations for steel connections** signed and sealed by a registered professional engineer.

1.3.4 Certifications

1.3.4.1 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**.

1.3.4.2 Overhead, Top Running Crane Rail Beam

Submit written field survey results for overhead, top running crane rail beam verifying tolerance requirements per CMAA 70.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide the structural steel system, including shop primer galvanizing, 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. Provide structural steel containing a minimum of 80 percent recycled content. Submit data identifying percentage of recycled content for structural steel.

2.2.2 Structural Steel Tubing

ASTM A500/A500M, Grade C. Provide structural steel tubing containing a minimum of 25 percent recycled content. Submit data identifying percentage of recycled content for structural steel tubing.

2.2.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B, weight class STD (Standard) or as indicated. Provide steel pipe containing a minimum of 50 percent recycled content. Submit data identifying percentage of recycled content for steel pipe.

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 mechanically deposited zinc coating. 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. Fasteners indicated to be galvanized shall be tested by the supplier to show that the galvanized nut with the supplied lubricant provided may be rotated from the snug tight condition well in excess of the rotation required for pretensioned installation without stripping. The supplier shall supply nuts that have been lubricated and tested with the supplied bolts.

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 Direct Tension Indicator Washers

ASTM F959/F959M. Submit product data for direct tension indicator washers.

2.3.2.4 Washers

ASTM F436/F436M, plain carbon steel.

2.3.3 Tension Control Bolts

ASTM F3125/F3125M, Grade F2280, Type 1, twistoff style assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon steel nuts, and hardened carbon steel washers. Assembly finish must be plain. Submit product data for tension control bolts.

2.3.4 Foundation Anchorage

2.3.4.1 Anchor Rods

ASTM F1554 Gr 36 , Class 1A.

2.3.4.2 Anchor Nuts

ASTM A563, Grade A, hex style.

2.3.4.3 Anchor Washers

ASTM F844.

2.3.4.4 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. Grout must be nonmetallic. 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 GALVANIZING

ASTM F2329/F2329M, ASTM F1136/F1136M, ASTM F2833 or ASTM B695 for threaded parts or ASTM A123/A123M for structural steel members, as applicable, unless specified otherwise galvanize after fabrication where practicable.

2.6 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.

Compression joints depending on contact bearing must have a surface roughness not in excess of 500 micro inch as determined by ASME B46.1, and ends must be square within the tolerances for milled ends specified in ASTM A6/A6M.

Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer.

2.6.1 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.

2.6.2 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, galvanized surfaces, surfaces to receive sprayed-on fireproofing, or surfaces within 0.5 inch of the toe of the welds prior to welding (except surfaces on which metal decking and shear studs are to be welded). If flash rusting occurs, re-clean the surface prior to application of primer. Apply primer to a minimum dry film thickness of 2.0 mil. Submit shop primer product data.

Prime slip critical surfaces with a Class B coating in accordance with AISC 325. Submit test report for Class B coating.

Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 45 degrees F or over 95 degrees F; or when

the primer may be exposed to temperatures below 40 degrees F within 48 hours after application, unless approved otherwise by the Contracting Officer. Repair damaged primed surfaces with an additional coat of primer.

2.6.2.1 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.

2.7 DRAINAGE HOLES

Drill adequate drainage holes to eliminate water traps. Hole diameter must be 1/2 inch and location indicated on the detail drawings. Hole size and locations must not affect the structural integrity.

PART 3 EXECUTION

3.1 ERECTION

- a. Erection of structural steel, except as indicated in item b. below, must be in accordance with the applicable provisions of AISC 325, AISC 303 and 29 CFR Part 1926, Subpart R.
- b. 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 base plates and 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

Provide direct tension indicator washers in all ASTM F3125/F3125M, Grade A325 and Grade A490 bolted connections. Bolts must be installed in connection holes and initially brought to a snug tight fit. After the

initial tightening procedure, fully tension bolts, progressing from the most rigid part of a connection to the free edges.

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.

3.2.2.1 Installation of Direct Tension Indicator Washers (DTIW)

Where possible, install the DTIW under the bolt head and tighten the nut. If the DTIW is installed adjacent to the turned element, provide a flat washer between the DTIW and nut when the nut is turned for tightening, and between the DTIW and bolt head when the bolt head is turned for tightening. In addition to the LIW, provide flat washers under both the bolt head and nut when [ASTM F3125/F3125M](#), Grade [A490](#) bolts are used.

3.2.3 Tension Control Bolts

Bolts must be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, fully tension bolts, progressing from the most rigid part of a connection to the free edges.

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](#). 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

Remove only from finished areas. Remove backing strips from bottom flange of moment connections, backgouge the root pass to sound weld metal and reinforce with a [5/16 inch](#) fillet weld minimum.

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 GALVANIZING REPAIR

Repair damage to galvanized coatings using [ASTM A780/A780M](#) zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.7 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.

3.7.1 Welds

3.7.1.1 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](#).

3.7.1.2 Nondestructive Testing

Nondestructive testing must be in accordance with [AWS D1.1/D1.1M](#). Ultrasonic testing must be performed in accordance with Table 6.2 of [AWS D1.1/D1.1M](#). Test locations must be selected by the Contracting Officer. All personnel performing NDT must be certified in accordance with [ANSI/ASNT CP-189](#) in the method of testing being performed. Submit certificates showing compliance with [ANSI/ASNT CP-189](#) for all [NDT technicians](#). If more than 20 percent of welds made by a welder contain defects identified by testing, then all groove welds made by that welder must be tested by ultrasonic testing, and all fillet welds made by that welder must be inspected by magnetic particle testing (MT) or dye penetrant testing (PT) as approved by the Contracting Officer. When groove welds made by an individual welder are required to be tested, magnetic particle or dye penetrant testing may be used only in areas inaccessible to ultrasonic testing. Retest all repaired areas. Submit [weld inspection reports](#).

Testing frequency: Provide the following types and number of tests:

Test Type	Number of Tests
Ultrasonic	100 percent of CJP Welds

3.7.2 Direct Tension Indicator Washers

3.7.2.1 Direct Tension Indicator Washer Compression

Test direct tension indicator washers in place to verify that they have been compressed sufficiently to provide the [0.015 inch](#) gap, as required by [ASTM F959/F959M](#). Submit [direct tension indicator washer inspection reports](#).

3.7.3 High-Strength Bolts

3.7.3.1 Testing Bolt, Nut, and Washer Assemblies

Test a minimum of 3 bolt, nut, and washer assemblies from each mill certificate batch in a tension measuring device at the job site prior to the beginning of bolting start-up. Demonstrate that the bolts and nuts, when used together, can develop tension not less than the provisions specified in [AISC 360](#), depending on bolt size and grade. The bolt tension must be developed by tightening the nut. A representative of the manufacturer or supplier must be present to ensure that the fasteners are properly used, and to demonstrate that the fastener assemblies supplied satisfy the specified requirements. Submit [bolt testing reports](#).

3.7.3.2 Inspection

Inspection procedures must be in accordance with [AISC 360](#). Confirm and report to the Contracting Officer that the materials meet the project specification and that they are properly stored. Confirm that the faying surfaces have been properly prepared before the connections are assembled. Observe the specified job site testing and calibration, and confirm that the procedure to be used provides the required tension. Monitor the work to ensure the testing procedures are routinely followed on joints that are specified to be fully tensioned.

3.7.3.3 Testing

The Government has the option to perform nondestructive tests on 5 percent of the installed bolts to verify compliance with pre-load bolt tension requirements. Provide the required access for the Government to perform the tests. The nondestructive testing will be done in-place using an ultrasonic measuring device or any other device capable of determining in-place pre-load bolt tension. The test locations must be selected by the Contracting Officer. If more than 10 percent of the bolts tested contain defects identified by testing, then all bolts used from the batch from which the tested bolts were taken, must be tested at the Contractor's expense. Retest new bolts after installation at the Contractor's expense.

3.7.4 Testing for Embrittlement

[ASTM A143/A143M](#) for steel products hot-dip galvanized after fabrication. Submit [embrittlement test reports](#).

3.7.5 Inspection and Testing of Steel Stud Welding

Perform verification inspection and testing of steel stud welding conforming to the requirements of [AWS D1.1/D1.1M](#), Stud Welding Clause. The Contracting Officer will serve as the verification inspector. Bend test studs that do not show a full 360 degree weld flash or have been repaired by welding as required by [AWS D1.1/D1.1M](#), Stud Welding Clause. Studs that crack under testing in the weld, base metal or shank will be rejected and replaced by the Contractor at no additional cost.

-- End of Section --

SECTION 05 30 00

STEEL DECKS

05/15, CHG 2: 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 IRON AND STEEL INSTITUTE (AISI)

AISI D100 (2017) Cold-Formed Steel Design Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding Code - Steel

AWS D1.3/D1.3M (2018) Structural Welding Code - Sheet Steel

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 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 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 D746 (2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

ASTM D1056 (2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber

ASTM D1149 (2007; R 2012) Standard Test Method for Rubber Deterioration - Surface Ozone

Cracking in a Chamber

ASTM E84

(2020) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM APP GUIDE

(updated on-line) Approval Guide
<http://www.approvalguide.com/>

FM DS 1-28R

(1998) Data Sheet: Roof Systems

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 20

(2019) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic)

STEEL DECK INSTITUTE (SDI)

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. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01

(2019, with Change 1, 2022) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926

Safety and Health Regulations for Construction

UNDERWRITERS LABORATORIES (UL)

UL 580

(2006; Reprint Mar 2019) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies

UL Fire Resistance

(2014) Fire Resistance Directory

1.2 SUBMITTALS

Government approval is required for all submittals. with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G

SD-03 Product Data

Accessories

Deck Units

Galvanizing Repair Paint

Touch-Up Paint

Welding Equipment

Welding Rods and Accessories

Recycled Content of Steel Products; S

SD-04 Samples

Metal Roof Deck Units

Flexible Closure Strips

SD-05 Design Data

Deck Units; G

SD-07 Certificates

Powder-Actuated Tool Operator

Welder Qualifications

Welding Procedures

Fire Safety

Wind Storm Resistance

Manufacturer's Certificate

Stud Manufacture's Certification

Stud Manufacture's Test Reports

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 and [AWS D1.1/D1.1M](#) for stud welding.

Submit qualified [Welder Qualifications](#) in accordance with [AWS D1.3/D1.3M](#) for sheet steel and [AWS D1.1/D1.1M](#) for stud 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 Regulatory Requirements

1.3.4.1 Fire Safety

Test roof deck as a part of a roof deck construction assembly of the type used for this project, listing as fire classified in the [UL Fire Resistance](#), or listing as Class I construction in the [FM APP GUIDE](#), and so labeled.

1.3.4.2 Wind Storm Resistance

Provide roof construction assembly capable of withstanding a nominal uplift pressure of [60 pounds per square foot](#) when tested in accordance with the uplift pressure test described in the [FM DS 1-28R](#) or as described in [UL 580](#) and in general compliance with [UFC 3-301-01](#).

1.3.5 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, cant strips, ridge and valley plates, 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.

Provide products with an average [recycled content of steel products](#) so postconsumer recycled content plus one half of preconsumer recycled content not less than 25 percent.

2.1.1 Roof Deck

Conform to [ASTM A792/A792M](#) or [ASTM A1008/A1008M](#) for deck used in conjunction with insulation and built-up roofing. Fabricate roof deck units of the steel design thickness required by the design drawings and galvanized. Furnish sample of [Metal Roof Deck Units](#) used to illustrate actual cross section dimensions and configurations.

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 shop-painted units of the same type used for the shop painting, and touch-up paint for zinc-coated units of an approved [galvanizing repair paint](#) with a high-zinc dust content. Touch-up welds with paint conforming to [SSPC Paint 20](#) in accordance with [ASTM A780/A780M](#). 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 parapets, end walls, eaves, and 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.

2.2.4 Flexible Closure Strips for Roof Decks

Provide strips made of vulcanized, closed-cell, synthetic rubber material specified and premolded to the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking.

Conforming to ASTM D1056, Grade 2A1, with the following additional properties:

Brittleness temperature of minus 40 degrees F when tested in accordance with ASTM D746.

Flammability resistance with a flame spread rating of less than 25 when tested in accordance with ASTM E84.

Resistance to ozone must be "no cracks" after exposure of a sample kept under a surface tensile strain of 25 percent to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 104 degrees F and tested in accordance with ASTM D1149.

Provide a elastomeric type adhesive as recommended by the manufacturer of the flexible closure strips.

2.2.5 Closure Plates for Composite Deck

Support and retain concrete at each floor level. Provide edge closures at all edges of the slab of sufficient strength and stiffness to support the wet concrete. Provide metal closures for all openings in composite steel deck 1/4 inch and over.

2.2.6 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.

2.2.7 Cover Plates

Sheet metal to close panel edge and end conditions, and where panels change direction or butt. Polyethylene-coated, self-adhesive, 2 inch wide joint tape may be provided in lieu of cover plates on flat-surfaced decking butt joints.

Fabricate cover plates for abutting floor deck units from the specified structural-quality steel sheets not less than nominal 18 gage thick before galvanizing. Provide 6 inch wide cover plates and form to match the

contour of the floor deck units.

2.2.8 Access Hole Covers

Sheet metal, minimum 0.0474 inch thick.

2.2.9 Hanger

Provide clips or loops for utility systems of one or more of the following types:

- a. Lip tabs or integral tabs where noncellular decking or flat plate of cellular section is 0.0474 inch thick or more, and a structural concrete fill is used over deck.
- b. Slots or holes punched in decking for installation of pigtails.
- c. Tabs driven from top side of decking and arranged so as not to pierce electrical cells.
- d. Decking manufacturer's standard as approved by the Contracting Officer.

2.2.10 Shear Connectors

Provide shear connectors in accordance with AWS D1.1/D1.1M headed stud Type B. Submit stud manufacture's certification that the studs delivered conform to the material requirements. Submit stud manufacture's test reports for the last completed in-plant quality control mechanical tests.

2.2.11 Cant Strips for Roof Decks

Fabricate cant strips from the specified commercial-quality steel sheets not less than nominal 0.0358 inch thick before galvanizing. Bend strips to form a 45-degree cant not less than 5 inch wide, with top and bottom flanges a minimum 3 inch wide. Length of strips 10 feet.

2.2.12 Ridge and Valley Plates for Roof Decks

Fabricate plates from the specified structural-quality steel sheets, not less than nominal 0.0358 inch thick before galvanizing. Provide plates of minimum 4-1/2 inch wide and bent to provide tight fitting closures at ridges and valleys. Provide a minimum length of ridge and valley plates of 10 feet.

2.2.13 Metal Closure Strips for Roof Decks

Fabricate strips from the specified commercial-quality steel sheets not less than nominal 0.0358 inch thick before galvanizing. Provide strips from the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking.

2.2.14 Galvanized Steel Angles for Roof Decks

Provide hot-rolled carbon steel angles conforming to ASTM A36/A36M, and hot-dip galvanized in accordance with ASTM A123/A123M.

2.2.15 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: saddles, 0.0474 inch 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, and 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. 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 inch diameter puddle welds, as indicated on the design drawings and in accordance with manufacturer's recommended procedure. Clamp or weight deck units to provide firm contact between deck units and structural supports while performing welding. 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. Conform to the recommendations of the Steel Deck Institute and the steel deck manufacturer for location, size, and spacing of fastening. Do use welding washers at the connections of the deck to supports. 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 Sidelap Fastening

Lock sidelaps between adjacent floor deck units together by welding or 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. Reinforce holes and openings larger than **12 inch** by steel channels or angles installed perpendicular to the steel joists and supported by the adjacent steel joists. Install steel channels or angles perpendicular to the deck ribs and fasten to the channels or angles perpendicular to the steel joists. 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 Roof Deck

After roof decking installation, wire brush, clean, and touchup paint the scarred areas on top and bottom surfaces of metal roof decking. The scarred areas include welds, weld scars, bruises, and rust spots. Touchup galvanized surfaces with galvanizing repair paint. Touchup painted surfaces with repair paint of painted surfaces.

3.2.4.2 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 Closures Above Partitions

Provide for closing voids between cells over partitions that are perpendicular to direction of cells. Provide a one-piece closure strip

for partitions 4 inch nominal or less in thickness and two-piece closure strips for wider partitions.

3.2.5.4 Cover Plates

Provide metal cover plates, or joint tape, at joints between cellular decking sheets to be used as electrical raceways.

3.2.5.5 Access Hole Covers

Provide access hole covers to seal holes cut in decking to facilitate welding of the deck to structural supports.

3.2.5.6 Hangers

Provide as indicated to support utility system . Space devices as indicated .

3.2.6 Preparation of Fire-Proofed Surfaces

Provide deck surfaces, both composite and noncomposite, which are to receive sprayed-on fireproofing, galvanized and free of all grease, mill oil, paraffin, dirt, salt, and other contaminants which impair adhesion of the fireproofing. Complete any required cleaning prior to steel deck installation using a cleaning method that is compatible with the sprayed-on fireproofing.

3.3 ROOF SUMP PANS

Place sump pans over openings in roof decking and fusion welded to top surface of roof decking. Do not exceed spacing of welds of 12 inch with not less than one weld at each corner. Field cut opening in the bottom of each roof sump pan to receive the roof drain as part of the work of this section.

3.4 CANT STRIPS FOR ROOF DECKS

Provide strips to be fusion welded to surface of roof decking, secured to wood nailers by galvanized screws or to steel framing by galvanized self-tapping screws or welds. Do not exceed spacing of welds and fasteners of 12 inch. Lap end joints a minimum 3 inch and secure with galvanized sheet metal screws spaced a maximum 4 inch on center.

3.5 RIDGE AND VALLEY PLATES FOR ROOF DECKS

Provide plates to be fusion welded to top surface of roof decking. Lap end joints a minimum 3 inch. For valley plates, provide endlaps to be in the direction of water flow.

3.6 CLOSURE STRIPS FOR ROOF DECKS

Provide closure strips at open, uncovered ends and edges of the roof decking and in voids between roof decking and top of walls and partitions where indicated. Install closure strips in position in a manner to provide a weathertight installation.

3.7 ROOF INSULATION SUPPORT FOR ROOF DECKS

Provide metal closure strips for support of roof insulation where rib

openings in top surface of metal roof decking occur adjacent to edges and openings. Weld metal closure strips in position.

3.8 CLEANING AND PROTECTION FOR ROOF DECKS

Upon completion of the deck, sweep surfaces clean and prepare for installation of the roofing.

3.9 FIELD QUALITY CONTROL

3.9.1 Headed Stud Inspection

In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

- a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
- b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.9.2 Deck Weld Inspection

Visual inspect welds in accordance with AWS D1.3/D1.3M.

3.9.3 Decks Not Receiving Concrete

Inspect the decking top surface for distortion after installation. For roof decks not receiving concrete, verify distortion by placing a straight edge across three adjacent top flanges. The maximum allowable gap between the straight edge and the top flanges should not exceed manufacturing and construction tolerances of supporting members. When gap is more than the allowable, provide corrective measures or replacement. Reinspect decking after performing corrective measures or replacement.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 05 40 00

COLD-FORMED METAL FRAMING

05/15, CHG 1: 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 CONCRETE INSTITUTE (ACI)

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 IRON AND STEEL INSTITUTE (AISI)

AISI S100 (2012) North American Specification for the Design of Cold-Formed Steel Structural Members

AISI S110 (2007; Suppl 1; Reaffirmed 2012) Standard for Seismic Design of Cold-Formed Steel Structural Systems - Special Bolted Moment Frames

AISI S200 (2007) North American Standard for Cold-Formed Steel Framing - General Provision

AISI S201 (2007) North American Standard for Cold-Formed Steel Framing - Product Data

AISI S202 (2011) Code of Standard Practice for Cold-formed Steel Structural Framing

AISI S211 (2007) North American Standard for Cold-Formed Steel Framing - Wall Stud Design

AISI S212 (2007) North American Standard for Cold-Formed Steel Framing - Header Design

AISI S213 (2007; Suppl 1 2009) North American Standard for Cold-Formed Steel Framing - Lateral Design

AISI S214 (2012) North American Standard for Cold-Formed Steel Framing - Truss Design

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding

Code - Steel

AWS D1.3/D1.3M

(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

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 A653/A653M

(2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A1003/A1003M

(2015) Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members

ASTM C955

(2017) Standard Specification for Cold-Formed Steel Structural Framing Members

ASTM C1007

(2020) Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories

ASTM C1513

(2018) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections

ASTM E119

(2020) Standard Test Methods for Fire Tests of Building Construction and Materials

ASTM E329

(2021) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

ASTM E488/E488M

(2022) Standard Test Methods for Strength of Anchors in Concrete Elements

ASTM F1554

(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

ASTM F1941

(2010) Standard Specification for Electrodeposited Coatings on Threaded

Fasteners (Unified Inch Screw Threads
(UN/UNR))

ASTM F2329/F2329M

(2015) Standard Specification for Zinc
Coating, Hot-Dip, Requirements for
Application to Carbon and Alloy Steel
Bolts, Screws, Washers, Nuts, and Special
Threaded Fasteners

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC

(2021) International Building Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01

(2019, with Change 1, 2022) Structural
Engineering

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Framing Components; G

SD-03 Product Data

Steel Studs, Joists, Tracks, Bracing, Bridging and Accessories

Recycled Content of Steel Products; S

SD-05 Design Data

Metal Framing Calculations; G

SD-07 Certificates

Welds

1.3 DELIVERY, STORAGE, AND HANDLING

Steel framing and related accessories shall be stored and handled in accordance with the AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

1.4 MAXIMUM DEFLECTION

Deflections of structural members shall not exceed the more restrictive of the limitations of ICC IBC and UFC 3-301-01.

1.5 QUALITY ASSURANCE

- a. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a registered professional

engineer.

- b. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to [ASTM E329](#) for testing indicated.
- c. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- d. Welding Qualifications: Qualify procedures and personnel according to the following:
 - (1) [AWS D1.1/D1.1M](#), "Structural Welding Code - Steel".
 - (2) [AWS D1.3/D1.3M](#), "Structural Welding Code - Sheet Steel".
- e. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per [ASTM E119](#) by, and displaying a classification label from, a testing and inspecting agency acceptable to authorities having jurisdiction.
- f. AISI Specifications and Standards: Comply with:
 - (1) [AISI S100](#), "North American Specification for the Design of Cold-Formed Steel Structural Members".
 - (2) [AISI S110](#), "Standard for Seismic Design of Cold-Formed Steel Structural Systems - Special Bolted Moment Frames".
 - (3) [AISI S200](#), "North American Standard for Cold-Formed Steel Framing - General Provision".
 - (4) [AISI S201](#), "North American Standard for Cold-Formed Steel Framing - Product Data".
 - (5) [AISI S202](#), "Code of Standard Practice for Cold-Formed Steel Structural Framing".
 - (6) [AISI S211](#), "North American Standard for Cold-Formed Steel Framing - Wall Stud Design".
 - (7) [AISI S212](#), "North American Standard for Cold-Formed Steel Framing - Header Design".
 - (8) [AISI S213](#), "North American Standard for Cold-Formed Steel Framing - Lateral Design".
 - (9) [AISI S214](#), "North American Standard for Cold-Formed Steel Framing - Truss Design".

1.5.1 Drawing Requirements

Submit [framing components](#) to show sizes, thicknesses, layout, material designations, methods of installation, and accessories including the following:

- a. Cross sections, plans, and/or elevations showing component types and locations for each framing application; including shop coatings and material thicknesses for each framing component.
- b. Connection details showing fastener type, quantity, location, and other information to assure proper installation.
- c. Drawings depicting panel configuration, dimensions, components, locations, and construction sequence if the Contractor elects to install prefabricated/prefinished frames.

Sign and seal fabrication drawings by a registered professional engineer.

1.5.2 Design Data Required

Submit [metal framing calculations](#) with design criteria and structural loading to verify sizes, thickness, and spacing of members and connections signed and sealed by a registered professional engineer. Show methods and practices used in installation.

PART 2 PRODUCTS

2.1 STEEL [STUDS](#), [JOISTS](#), TRACKS, BRACING, BRIDGING AND ACCESSORIES

Framing components shall comply with [ASTM C955](#) and the following.

- a. Provide products with an average [recycled content of steel products](#) so postconsumer recycled content plus one half of preconsumer recycled content not less than 25 percent.
- b. Steel Sheet: [ASTM A1003/A1003M](#), Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
 - (1) Grade: As required by structural performance.
 - (2) Coating: G60 (Z180), A60 (ZF180), AZ50 (AZ150), or GF30 (ZGF90).
- c. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - (1) Minimum Base-Metal Thickness: [0.0428 inch](#).
 - (2) Flange Width: [1-5/8 inches](#).
- d. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
 - (1) Minimum Base-Metal Thickness: [0.0428 inch](#).
 - (2) Flange Width: [1-1/4 inches](#).
- e. Roof Truss Members: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:
 - (1) Minimum Base-Metal Thickness: [0.0428 inch](#).
 - (2) Flange Width: [1-5/8 inches, minimum at top and bottom chords](#)

connecting to sheathing or directly fastened construction.

2.1.1 Studs and Joists of 54 mils (0.054 Inch) and Heavier

Galvanized steel, ASTM A653/A653M and ASTM A1003/A1003M, SS Grade 50, G60 .

2.1.2 Studs and Joists of 43 mils (0.043 Inch) and Lighter

Studs and Joists of 43 mils (0.043 Inch) and Lighter, Track, and Accessories (All thicknesses): Galvanized steel, ASTM A653/A653M and ASTM A1003/A1003M, SS, Grade 33 33,000 psi G60.

2.1.3 Sizes, Thickness, Section Modulus, and Other Structural Properties

Size and thickness as required.

2.2 MARKINGS

Studs and track shall have product markings stamped on the web of the section. The markings shall be repeated throughout the length of the member at a maximum spacing of 4 feet on center and shall be legible and easily read. The product marking shall include the following:

- a. An ICC number.
- b. Manufacturer's identification.
- c. Minimum delivered uncoated steel thickness.
- d. Protective coating designator.
- e. Minimum yield strength.

2.3 CONNECTIONS

2.3.1 Steel-To-Concrete Connections

- a. Anchor Rods: ASTM F1554, Grade 36; galvanized per ASTM A153/A153M.
- b. Post-Installed Concrete Anchors: Adhesive or expansion anchors fabricated from corrosion-resistant materials with allowable load capacities in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.
- c. Power-Actuated Fasteners: Fabricated from corrosion-resistant materials with allowable load capacities in accordance with ICC-ES AC 70 greater than or equal to the design load as determined by testing per ASTM E1190 conducted by a qualified testing agency.

2.3.2 Steel-To-Steel Connections

- a. Screws: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping steel screws of the type and size indicated. Provide low-profile head beneath sheathing and manufacturer's standard elsewhere. Electroplated to a minimum of 5 micron zinc coating per ASTM F1941 or hot-dipped galvanized per ASTM A123/A123M or ASTM A153/A153M.

- b. Bolts: **ASTM A307** coated by hot-dip process per **ASTM F2329/F2329M** or zinc-coated by mechanical-deposition process per ASTM B695, Class 55.
- c. Welding Electrodes: Comply with AWS standards.

2.4 PLASTIC GROMMETS

Supply plastic grommets for stud webs as recommended by stud manufacturer, to protect electrical wires and plumbing piping. Prevent metal-to-metal contact between wiring/piping and studs.

2.5 SEALER GASKET

Closed-cell neoprene foam, **1/4-inch** thick, selected from manufacturer's standard widths to match width of bottom track on concrete slab or foundation.

PART 3 EXECUTION

3.1 TRUSS FABRICATION

- a. Fabricate cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
- b. Truss must be fabricated either on site or off site prior to erection.
- c. Fabricate trusses using jigs or templates.
- d. Splices can only occur at joints.
- e. Cut truss members by sawing or shearing: do not torch cut.
- f. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.
- g. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- h. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses to prevent damage or permanent distortion.

3.2 FASTENING

Fasten framing members together by welding or by using self-drilling, self-tapping screws. Electrodes and screw connections shall be as required and indicated in the design calculations.

3.2.1 Welds

All welding shall be performed in accordance with **AWS D1.3/D1.3M**, as modified by **AISI S100**. All welders, welding operations, and welding procedures shall be qualified according to **AWS D1.3/D1.3M**. Submit certified copies of welder qualifications test records showing qualification in accordance with **AWS D1.3/D1.3M**. All welds shall be

cleaned and coated with rust inhibitive galvanizing paint. Do not field weld materials lighter than 43 mils.

3.2.2 Screws

Screws shall be of the self-drilling self-tapping type, size, and location as required. Screw penetration through joined materials shall not be less than three exposed threads. Minimum spacings and edge distances for screws shall be as specified in AISI S100. Screws covered by sheathing materials shall have low profile heads.

3.2.3 Anchors

Anchors shall be of the type, size, and location as required.

3.2.4 Powder-Actuated Fasteners

Powder-actuated fasteners shall be of the type, size, and location as required.

3.3 INSTALLATION

Install cold-formed framing in accordance with ASTM C1007 and AISI S200.

Install cold-formed steel framing according to AISI S202 and to manufacturer's written instructions unless more stringent requirements are indicated.

3.3.1 Tracks

Provide accurately aligned runners at top and bottom of studs. Install sealer gasket under bottom of track on concrete slab or foundation. Anchor tracks as indicated in design calculations. Butt weld joints in tracks or splice with stud inserts. Fasteners shall be at least 3 inches from the edge of concrete slabs.

3.3.2 Studs

Cut studs square and set with firm bearing against webs of top and bottom tracks. Position studs vertically in tracks and space as indicated in design. Do not splice studs. Provide at least two studs at jambs of doors and other openings 2 feet wide or larger. Provide jack studs over openings, as necessary, to maintain indicated stud spacing. Provide tripled studs at corners, positioned to receive interior and exterior finishes. Fasten studs to top and bottom tracks by welding or screwing both flanges to the tracks. Framed wall openings shall include headers and supporting components as shown on the drawings. Headers shall be installed in all openings that are larger than the stud spacing in a wall. In curtain wall construction, provide for vertical movement where studs connect to the structural frame. Provide horizontal bracing in accordance with the design calculations and AISI S100. Bracing shall be not less than the following:

<u>LOAD</u>	<u>HEIGHT</u>	<u>BRACING</u>
Wind load only	Up to 10 feet	One row at mid-height
	Over 10 feet	Rows 5'-0" o.c. maximum
Axial load	Up to 10 feet	Two rows at 1/3 points
	Over 10 feet	Rows 3'-4" o.c. maximum

3.3.3 Joists and Trusses

- a. Provide a stud directly under each joist or truss. The maximum spacing of studs as indicated shall be maintained.
- b. Install, bridge, and brace cold-formed steel trusses according to **AISI S200**, **AISI S214**, AISI's "Code of Standard Practice for Cold-Formed Steel Structural Framing," and manufacturer's written instructions unless more stringent requirements are indicated.
- c. Install temporary bracing and supports. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- d. Do not alter, cut, or remove framing members or connections of trusses.

3.3.4 Erection Tolerances

- a. Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:
 - (1) Layout of walls and partitions: 1/4 inch from intended position;
 - (2) Plates and runners: 1/4 inch in 8 feet from a straight line;
 - (3) Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and
 - (4) Face of framing members: 1/4 inch in 8 feet from a true plane.
- b. Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive shall be within the following limits:
 - (1) Layout of walls and partitions: 1/4 inch from intended position;
 - (2) Plates and runners: 1/8 inch in 8 feet from a straight line;

(3) Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and

(4) Face of framing members: 1/8 inch in 8 feet from a true plane.

-- End of Section --

SECTION 05 51 00

METAL STAIRS

02/17, CHG 1: 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 M 314 (1990; R 2013) Standard Specification for
Steel Anchor Bolts

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360 (2016) Specification for Structural Steel
Buildings

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121 (2007) Standard Definitions for Use in the
Design of Steel Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.6.3 (2013; R 2017) Machine Screws, Tapping
Screws, and Machine Drive Screws (Inch
Series)

ASME B18.21.1 (2009; R 2016) Washers: Helical
Spring-Lock, Tooth Lock, and Plain Washers
(Inch Series)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding
Code - Steel

ASTM INTERNATIONAL (ASTM)

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 2021) Standard Specification for
Gray Iron Castings

ASTM A53/A53M (2022) Standard Specification for Pipe,

Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless

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 A283/A283M	(2013) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2021) 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 A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A500/A500M	(2021a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A512	(2006; R 2012) Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A575	(2020) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
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	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
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 C514

(2004; R 2020) Standard Specification for
Nails for the Application of Gypsum Board

ASTM C636/C636M

(2013) Standard Practice for Installation
of Metal Ceiling Suspension Systems for
Acoustical Tile and Lay-In Panels

ASTM E488/E488M

(2022) Standard Test Methods for Strength
of Anchors in Concrete Elements

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Iron and Steel Hardware; G

Steel Shapes, Plates, Bars, and Strips; G

Metal Stair System; G

SD-03 Product Data

Structural Steel Plates, Shapes, and Bars; G

Structural Steel Tubing; G

Hot-Rolled Carbon Steel Sheets and Strips; G

Cold-Finished Steel Bars; G

Hot-Rolled Carbon Steel Bars; G

Cold-Rolled Carbon Steel Sheets; G

Galvanized Carbon Steel Sheets; G

Cold-Drawn Steel Tubing; G

Gray Iron Castings; G

Malleable Iron Castings; G

Masonry Anchorage Devices; G

Protective Coating; G

Steel Pan Stairs; G

Steel Stairs; G

SD-07 Certificates

Welding Procedures; G

Welder Qualification; G

SD-08 Manufacturer's Instructions

Structural Steel Plates, Shapes, and Bars; G

Structural Steel Tubing; G

Hot-Rolled Carbon Steel Sheets and Strips; G

Cold-Finished Steel Bars; G

Hot-Rolled Carbon Steel Bars; G

Cold-Rolled Carbon Steel Sheets; G

Galvanized Carbon Steel Sheets; G

Cold-Drawn Steel Tubing; G

Gray Iron Castings; G

Malleable Iron Castings; G

Protective Coating; G

Masonry Anchorage Devices; G

1.3 QUALITY CONTROL

1.3.1 Qualifications for Welding Work

Submit [welding procedures](#) in accordance with [AWS D1.1/D1.1M](#). Make test specimens in the presence of the Contracting Officer, and have the specimens tested by an approved testing laboratory at the Contractor's expense.

Certify [welder qualification](#) by tests in accordance with [AWS D1.1/D1.1M](#), or under an equivalent approved qualification test. In addition, perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, ensure that two test welds are retested immediately and that each test weld is made and passes. Failure in the immediate retest requires that the welder be retested after further practice or training and a complete set of test welds be made.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit complete and detailed fabrication drawings for [iron and steel hardware](#), and for [steel shapes, plates, bars, and strips](#) used in accordance with the design specifications referenced in this section.

2.2 FABRICATION

Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, before cleaning and treating surfaces and applying surface finishes, including zinc coatings.

2.2.1 General Fabrication

Prepare and submit [metal stair system](#) shop drawings with detailed plans and elevations at scales not less than [1 inch to 1 foot](#) and with details of sections and connections at scales not less than [3 inches to 1 foot](#). Also detail the placement drawings, diagrams, and templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchorage devices.

Use materials of size and thicknesses indicated or, if not indicated, of the size and thickness necessary to produce a finished product that is strong enough and durable enough for its intended use. Work the materials to the dimensions indicated on approved detail drawings, using proven methods of fabrication and support. Use the type of materials indicated or specified for the various components of work.

Form exposed work true to line and level, with accurate angles and surfaces and with straight sharp edges. Ease exposed edges to a radius of approximately [1/32 inch](#), and bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Continuously weld corners and seams in accordance with the recommendations of [AWS D1.1/D1.1M](#). Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use Phillips flat-head (countersunk) screws or bolts.

Provide and coordinate anchorage of the type indicated for the supporting structure. Fabricate anchoring devices, and space them as indicated and as necessary to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified as fabricated from cold-finished or cold-rolled stock.

2.2.2 Steel Pan Stairs

2.2.2.1 General

Joining pieces by welding. Fabricate units so that bolts and other fastenings do not appear on finished surfaces. Make joints true and tight, and connections between parts lighttight. Grind continuous welds smooth where exposed.

Construct metal stair units to sizes and arrangements indicated to support a minimum live load of 100 pounds per square foot. Provide framing, hangers, columns, struts, clips, brackets, bearing plates, and other components as required for the support of stairs and platforms.

2.2.2.2 Stair Framing

Fabricate stringers of structural steel channels, or plates, or a combination thereof as indicated. Provide closures for exposed ends of strings.

Construct platforms of structural steel channel headers and miscellaneous framing members as indicated. Bolt headers to stringers and newels, and bolt framing members to stringers and headers.

2.2.2.3 Riser, Subtread, and Subplatform Metal Pans

Form metal pans of 0.1084-inch (12-gage) galvanized structural steel sheets, conforming to ASTM A653/A653M, Grade A, with zinc coating conforming to ASTM A653/A653M and ASTM A924/A924M. Shape the pans to the configuration indicated.

Construct risers and subtread metal pans with steel angle supporting brackets, of the size indicated, welded to stringers. Secure metal pans to brackets with rivets or welds. Secure subplatform metal pans to platform frames with welds.

2.2.2.4 Steel Framing for Concrete Stairs

When necessary, modify fabricated units to fit actual dimensions of the supporting structure. Join steel components by welding. Provide 14-gage steel risers unless otherwise indicated. Arrange components to receive finish materials as indicated.

2.2.3 Protective Coating

Shop-prime interior steelwork as indicated in accordance with AISC/AISI 121, except surfaces of steel encased in concrete; welded surfaces; high-strength, bolt-connected surfaces; and surfaces of crane rails.

Hot-dip galvanize exterior steelwork as indicated in accordance with ASTM A123/A123M. Touch up abraded surfaces and cut ends of galvanized members with zinc-dust, zinc-oxide primer, or an approved galvanizing repair compound.

2.3 COMPONENTS

2.3.1 Steel Stairs

Provide steel stairs complete with stringers, metal-pan concrete-filled

treads, landings, columns, handrails, and necessary bolts and other fastenings. Hot-dip-galvanize exterior steel stairs and accessories. Shop-paint interior steel stairs and accessories.

2.3.1.1 Design Loads

Design stairs to sustain a live load of not less than 100 pounds per square foot, or a concentrated load of 300 pounds applied where it is most critical. Except for a commercial product, design and fabricate steel stairs to conform to AISC 360.

2.3.1.2 Materials

Provide steel stairs of welded construction except that bolts may be used where welding is not practicable. Do not use screw or screw-type connections.

- a. Structural Steel: ASTM A36/A36M.
- b. Support metal pan for concrete fill on angle cleats welded to stringers or treads with integral cleats, welded or bolted to the stringer. Provide sheet-steel landings with angle stiffeners welded on. Close exposed ends. For exterior stairs, form all exposed joints to exclude water.
- c. Before fabrication, obtain necessary field measurements and verify drawing dimensions.
- d. Clean metal surfaces free of mill scale, flake rust, and rust pitting before shop finishing. Weld permanent connections. Finish welds flush and smooth on surfaces that will be exposed after installation.

2.3.2 Masonry Anchorage Devices

Provide masonry anchorage devices consisting of expansion shields complying with AASHTO M 314, ASTM E488/E488M and ASTM C514 as follows:

- a. Lead expansion shields for machine screws and bolts 1/4 inch and smaller; head-out embedded-nut type, single unit class, Group I, Type 1, Class 1.
- b. Lead expansion shields for machine screws and bolts larger than 1/4 inch in size; head-out embedded-nut type, multiple unit class, Group I, Type 1, Class 2.
- c. Bolt anchor expansion shields for lag bolts; zinc-alloy, long-shield anchors class, Group II, Type 1, Class 1.
- d. Bolt anchor expansion shields for bolts; closed-end bottom-bearing class, Group II, Type 2, Class 1.

Use toggle bolts of the tumble-wing type, conforming to ASTM A325, ASTM A449, and ASTM C636/C636M, type, class, and style as required.

2.3.3 Fasteners

Select galvanized zinc-coated fasteners conforming to ASTM A153/A153M for exterior applications or where the fasteners are built into exterior walls or floor systems. Select the fasteners for the type, grade, and class

required for the installation of steel stair items:

- a. Standard/regular hexagon-head bolts and nuts, conforming to [ASTM A307](#), Grade A.
- b. Cadmium-plated steel machine screws, conforming to [ASME B18.6.3](#).
- c. Plain, round, general-assembly-grade, carbon steel washers, conforming to [ASME B18.21.1](#).

2.4 MATERIALS

2.4.1 Structural Steel Plates, Shapes and Bars

Structural size shapes and plates, conforming to [ASTM A36/A36M](#), unless otherwise noted, except bent or cold-formed plates.

Steel plates - bent or cold-formed, conforming to [ASTM A283/A283M](#), Grade C.

Steel bars and bar-size shapes, conforming to [ASTM A36/A36M](#), unless otherwise noted for steel bars and bar-size shapes.

2.4.2 Structural Steel Tubing

Provide the following:

- a. Structural steel tubing, hot-formed, welded or seamless, conforming to [ASTM A500/A500M](#), Grade B, unless otherwise noted.

2.4.3 Hot-Rolled Carbon Steel Bars

Provide the following:

- a. Hot-rolled carbon steel bars and bar-size shapes, conforming to [ASTM A575](#), grade as selected by the fabricator.

2.4.4 Cold-Finished Steel Bars

Provide the following:

- a. Cold-finished steel bars conforming to [ASTM A108](#), grade as selected by the fabricator.

2.4.5 Hot-Rolled Carbon Steel Sheets and Strips

Provide the following:

- a. Hot-rolled carbon sheets and strips conforming to [ASTM A568/A568M](#) and [ASTM A1011/A1011M](#), pickled and oiled.

2.4.6 Cold-Rolled Carbon Steel Sheets

Provide the following:

- a. Cold-rolled carbon steel sheets conforming to [ASTM A1008/A1008M](#).

2.4.7 Galvanized Carbon Steel Sheets

Provide the following:

- a. Galvanized carbon steel sheets conforming to ASTM A653/A653M, with galvanizing conforming to ASTM A653/A653M and ASTM A924/A924M.

2.4.8 Cold-Drawn Steel Tubing

Provide the following:

- a. Cold-drawn steel tubing conforming to ASTM A512, sunk drawn, butt-welded, cold-finished, and stress-relieved.

2.4.9 Gray Iron Castings

Provide the following:

- a. Gray iron castings conforming to ASTM A48/A48M, Class 30.

2.4.10 Malleable Iron Castings

Provide the following:

- a. Malleable iron castings conforming to ASTM A47/A47M, grade as selected.

2.4.11 Steel Pipe

Provide the following:

- a. Steel pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

PART 3 EXECUTION

3.1 PREPARATION

Clean surfaces thoroughly before installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions. Examine materials upon arrival at site. Notify the carrier and manufacturer of any damage.

Protect installed products until completion of project. Touch up, repair or replace, damaged products before substantial completion

3.2 INSTALLATION

Install in accordance with the manufacturer's instructions and approved submittals. Install in proper relationship with adjacent construction.

Install items at locations indicated, according to the manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Ensure that exposed fastenings are compatible with generally match the color and finish of, and harmonize with the material to which they are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners is cause for rejection. Conceal fastenings where practicable. Select thickness of metal and details of assembly and supports that adequately strengthen and stiffen the construction. Form joints exposed to the weather to exclude water.

3.2.1 Field Preparation

Remove rust-preventive coating just before field erection, using a remover approved by the coating manufacturer. Provide surfaces, when assembled, free of rust, grease, dirt and other foreign matter.

3.2.2 Field Welding

Comply with AWS D1.1/D1.1M in executing manual shielded-metal arc welding, (for appearance and quality of new welds) and in correcting existing welding.

3.2.3 Touchup Painting

Immediately after installation, clean all field welds, bolted connections, and abraded areas of the shop-painted material, and repaint exposed areas with the same paint used for shop painting. Apply paint by brush or spray to provide a minimum dry-film thickness of 2 mils.

-- End of Section --

SECTION 05 52 00

METAL RAILINGS
02/18, CHG 1: 02/20

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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 314 (1990; R 2013) Standard Specification for
Steel Anchor Bolts

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.6.3 (2013; R 2017) Machine Screws, Tapping
Screws, and Machine Drive Screws (Inch
Series)

ASME B18.21.1 (2009; R 2016) Washers: Helical
Spring-Lock, Tooth Lock, and Plain Washers
(Inch Series)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding
Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M (2020) Standard Specification for Steel
Castings, Carbon, for General Application

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 A53/A53M (2022) Standard Specification for Pipe,
Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless

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 A283/A283M	(2013) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A500/A500M	(2021a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A512	(2006; R 2012) Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
ASTM A575	(2020) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 521	(2001; R 2012) Pipe Railing Systems Manual
---------------	--

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Iron and Steel Hardware; G

Steel Shapes, Plates, Bars and Strips; G

SD-03 Product Data

Structural-Steel Plates, Shapes, and Bars; G

Structural-Steel Tubing; G

Cold-Finished Steel Bars; G

Hot-Rolled Carbon Steel Bars; G

Cold-Drawn Steel Tubing; G

Concrete Inserts; G

Masonry Anchorage Devices; G

Protective Coating; G

Steel Railings and Handrails; G

SD-07 Certificates

Welding Procedures; G

Welder Qualification; G

SD-08 Manufacturer's Instructions

Installation Instructions

1.3 QUALITY CONTROL

1.3.1 Welding Procedures

Submit results of [welding procedures](#) testing in accordance with [AWS D1.1/D1.1M](#) made in the presence of the Contracting Officer and by an approved testing laboratory at the Contractor's expense.

1.3.2 Welder Qualification

Submit certified [welder qualification](#) by tests in accordance with [AWS D1.1/D1.1M](#), or under an equivalent approved qualification test. In addition, perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, conduct an immediate retest of two test welds and ensure that each test weld passes. Failure in the immediate retest will require that the welder be retested after further practice or training and make a complete set of test welds.

PART 2 PRODUCTS

2.1 FABRICATION

Preassemble items in the shop to the greatest extent possible.
Disassemble units only to the extent necessary for shipping and handling.

Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, before cleaning, treating, and applying surface finishes, including zinc coatings.

Provide railing and handrail detail plans and elevations at not less than **1 inch to 1 foot**. Provide details of sections and connections at not less than **3 inches to 1 foot**. Also detail setting drawings, diagrams, templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchors.

Use materials of size and thicknesses indicated or, if not indicated, of the size and thickness necessary to produce adequate strength and durability in the finished product for its intended use. Work the materials to the dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use the type of materials indicated or specified for the various components of work.

Form exposed work true to line and level, with accurate angles and surfaces and straight sharp edges. Ensure that all exposed edges are eased to a radius of approximately **1/32 inch**. Bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Weld corners and seams continuously and in accordance with the recommendations of **AWS D1.1/D1.1M**. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form the exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use countersunk Phillips flathead screws or bolts.

Provide anchorage of the type indicated and coordinated with the supporting structure. Fabricate anchoring devices and space as indicated and as required to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified to be fabricated from cold-finished or cold-rolled stock.

2.1.1.1 Steel Handrails

Fabricate joint posts, rail, and corners by one of the following methods:

- a. Flush-type rail fittings of commercial standard, welded and ground smooth, with railing splice locks secured with **3/8 inch** hexagonal-recessed-head setscrews.
- b. Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove-welding joints, and grinding smooth. Butt railing splices and reinforce them by a tight-fitting interior sleeve not less than **6 inches** long.
- c. Railings may be bent at corners in lieu of jointing, provided that

bends are made in suitable jigs and the pipe is not crushed.

2.1.2 Protective Coating

Shop-prime interior steelwork as indicated in accordance with Section 09 90 00 PAINTS AND COATINGS except the following:

- a. steel surfaces encased in concrete
- b. steel surfaces for welding
- c. high-strength bolt-connected contact surfaces

Provide hot-dipped galvanized exterior steelwork as indicated in accordance with ASTM A123/A123M. Touch up abraded surfaces and cut ends of galvanized members with zinc-dust, zinc-oxide primer, or an approved galvanizing repair compound.

2.2 COMPONENTS

2.2.1 Structural Steel Plates, Shapes And Bars

Provide structural-size shapes and plates, except plates to be bent or cold-formed, conforming to ASTM A36/A36M, unless otherwise noted.

Provide steel plates, to be bent or cold-formed, conforming to ASTM A283/A283M, Grade C.

Provide steel bars and bar-size shapes conforming to ASTM A36/A36M, unless otherwise noted.

2.2.2 Structural-Steel Tubing

Provide structural-steel tubing, hot-formed, welded or seamless, conforming to ASTM A500/A500M, Grade B, unless otherwise noted.

2.2.3 Hot-Rolled Carbon Steel Bars

Provide bars and bar-size shapes conforming to ASTM A575, grade as selected by the fabricator.

2.2.4 Cold-Finished Steel Bars

Provide cold-finished steel bars conforming to ASTM A108, grade as selected by the fabricator.

2.2.5 Cold-Drawn Steel Tubing

Provide tubing conforming to ASTM A512, sunk-drawn, butt-welded, cold-finished, and stress-relieved.

2.2.6 Steel Pipe

Provide pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

2.2.7 Concrete Inserts

Provide threaded-type concrete inserts consisting of galvanized ferrous castings, internally threaded to receive 3/4 inch diameter machine bolts; either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M, hot-dip galvanized in accordance with ASTM A153/A153M.

Provide wedge-type concrete inserts consisting of galvanized box-type ferrous castings designed to accept 3/4 inch diameter bolts having special wedge-shaped heads, made of either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M and hot-dip galvanized in accordance with ASTM A153/A153M.

2.2.8 Masonry Anchorage Devices

Provide masonry anchorage devices consisting of expansion shields complying with AASHTO M 314, ASTM E488/E488M and ASTM C514 as follows:

Provide lead expansion shields for machine screws and bolts 1/4 inch and smaller; head-out embedded nut type, single-unit class, Group I, Type 1, Class 1.

Provide lead expansion shields for machine screws and bolts larger than 1/4 inch in size; head-out embedded nut type, multiple-unit class, Group I, Type 1, Class 2.

Provide bolt anchor expansion shields for lag bolts; zinc-alloy, long-shield anchor class, Group II, Type 1, Class 1.

Provide bolt anchor expansion shields for bolts; closed-end bottom-bearing class, Group II, Type 2, Class 1.

Provide tumble-wing-type toggle bolts conforming to ASTM F3125/F3125M, ASTM A449 and ASTM C636/C636M, type, class, and style as required.

2.2.9 Fasteners

Provide galvanized zinc-coated fasteners in accordance with ASTM A153/A153M used for exterior applications or where built into exterior walls or floor systems. Select fasteners for the type, grade, and class required for the installation of steel stair items.

Provide standard hexagon-head bolts, conforming to ASTM A307, Grade A.

Provide cadmium-plated steel machine screws conforming to ASME B18.6.3.

Provide plain round, general-assembly-grade, carbon steel washers conforming to ASME B18.21.1.

2.2.10 Steel Railings And Handrails

Design handrails to resist a concentrated load of 200 lb in any direction at any point of the top of the rail or 50 lb per foot applied horizontally to the top of the rail, whichever is more severe. NAAMM AMP 521, provide the same size rail and post. Provide pipe collars of the same material and finish as the handrail and posts. Provide series 300 stainless-steel pipe collars.

2.2.10.1 Steel Handrails

Provide steel handrails, including inserts in concrete, steel pipe conforming to **ASTM A53/A53M** or structural tubing conforming to **ASTM A500/A500M**, Grade A or B of equivalent strength. Provide steel railings of **1 1/2 inch** nominal size, hot-dip galvanized for exterior installations and shop-painted for interior installations.

Provide kickplates between railing posts where indicated, and consisting of **1/8 inch** steel flat bars not less than **6 inches** high. Secure kickplates as indicated.

Galvanize exterior railings, including pipe, fittings, brackets, fasteners, and other ferrous metal components. Provide black steel pipe for interior railings.

PART 3 EXECUTION

3.1 PREPARATION

Adjust stair railings and handrails before securing in place in order to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than **6 feet** on center. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

- a. Anchor posts in concrete by means of pipe sleeves set and anchored into concrete. Provide sleeves of galvanized, standard-weight, steel pipe, not less than **6 inches** long, and having an inside diameter not less than **1/2 inch** greater than the outside diameter of the inserted pipe post. Provide steel plate closure secured to the bottom of the sleeve, with closure width and length not less than **1 inch** greater than the outside diameter of the sleeve. After posts have been inserted into sleeves, fill the annular space between the post and sleeve with nonshrink grout or a quick-setting hydraulic cement. Cover anchorage joint with a round steel flange welded to the post.
- b. Anchor posts to steel with oval steel flanges, angle type or floor type as required by conditions, welded to posts and bolted to the steel supporting members.
- c. Anchor rail ends into concrete and masonry with round steel flanges welded to rail ends and anchored into the wall construction with lead expansion shields and bolts.
- d. Anchor rail ends to steel with oval or round steel flanges welded to tail ends and bolted to the structural-steel members.

Secure handrails to walls by means of wall brackets and wall return fitting at handrail ends. Provide brackets of malleable iron castings, with not less than **3 inch** projection from the finished wall surface to the center of the pipe, drilled to receive one **3/8 inch** bolt. Locate brackets not more than **60 inches** on center. Provide wall return fittings of cast iron castings, flush type, with the same projection as that specified for wall brackets. Secure wall brackets and wall return fittings to building construction as follows:

- a. For concrete and solid masonry anchorage, use bolt anchor expansion shields and lag bolts.

- b. For hollow masonry and stud partition anchorage, use toggle bolts having square heads.

Install toe boards and brackets. Make splices, where required, at expansion joints.

3.2 INSTALLATION

Submit manufacturer's [installation instructions](#) for the following products to be used in the fabrication of steel stair railing and hand rail work:

- a. Structural-steel plates, shapes, and bars
- b. Structural-steel tubing
- c. Cold-finished steel bars
- d. Hot-rolled carbon steel bars
- e. Cold-drawn steel tubing
- f. Protective coating
- g. Masonry anchorage devices
- h. Steel railings and handrails

Provide complete, detailed fabrication and installation drawings for all [iron and steel hardware](#), and for all [steel shapes, plates, bars, and strips](#) used in accordance with the design specifications cited in this section.

3.2.1 Steel Handrail

Install handrail in pipe sleeves embedded in concrete and filled with nonshrink grout or quick-setting anchoring cement with anchorage covered with standard pipe collar pinned to post. [Also install](#) by means of base plates bolted to stringers or structural-steel frame work. Secure rail ends by steel pipe flanges anchored by expansion shields and bolts.

3.2.2 Touchup Painting

Immediately after installation, clean field welds, bolted connections, abraded areas of the shop paint, and exposed areas painted with the paint used for shop painting. Apply paint by brush or spray to provide a minimum dry-film thickness of [2 mils](#).

3.3 FIELD QUALITY CONTROL

3.3.1 Field Welding

Ensure that procedures of manual shielded metal arc welding, appearance and quality of welds made, and methods used in correcting welding work comply with [AWS D1.1/D1.1M](#).

-- End of Section --

SECTION 06 10 00

ROUGH CARPENTRY
08/16, CHG 2: 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 LUMBER STANDARDS COMMITTEE (ALSC)

ALSC PS 20 (2015) American Softwood Lumber Standard

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 B18.5.2.1M (2006; R 2011) Metric Round Head Short Square Neck Bolts

ASME B18.5.2.2M (1982; R 2010) Metric Round Head Square Neck Bolts

AMERICAN WOOD COUNCIL (AWC)

AWC NDS (2015) National Design Specification (NDS) for Wood Construction

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 (2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use

AWPA M6 (2013) Brands Used on Preservative Treated Materials

AWPA P5 (2015) Standard for Waterborne Preservatives

AWPA P18 (2014) Nonpressure Preservatives

AWPA U1 (2022) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M (2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM F547 (202) Standard Terminology of Nails for Use with Wood and Wood-Base Materials

FM GLOBAL (FM)

FM 4435 (2013) Roof Perimeter Flashing

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC (2021) International Building Code

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1003 (2014) Standard Grading Rules for Southern Pine Lumber

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Preservative-treated Lumber and Plywood

SD-07 Certificates

Certificates of Grade

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 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.

Pressure treated material for roof constructions:

1. **AWPA U1, UC3B, Commodity Specification A, Sawn Products, various sizes, No. 2 Grade lumber**
2. **AWPA U1, UC3B, Commodity Specification F, Wood Composites, Grade C-C Plugged, Group 1, various thicknesses, Exterior Exposure plywood**

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

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. **0.40 pcf** intended for ground contact and fresh water use. 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. 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. All lumber and woodwork must be preservative treated. The following items must be preservative treated:

(1) 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 CERTIFICATIONS

1.8.1 Certified Wood Grades

Provide certificates of grade from the grading agency on graded but unmarked lumber or plywood attesting that materials meet the grade requirements specified herein.

PART 2 PRODUCTS

2.1 LUMBER

2.1.1 Framing Lumber

Framing lumber must be one of the species listed in the table below. Minimum grade of species must be as listed.

SECTION 06 10 00 Page 5

<u>Table of Grades for Framing and Board Lumber</u>			
<u>Grading Rules</u>	<u>Species</u>	<u>Framing</u>	<u>Board Lumber</u>
SP1B 1003 standard grading rules	Southern Pine	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 10 feet and shorter)	No. 2 Boards

<u>Table of Grades for Framing and Board Lumber</u>			
<u>Grading Rules</u>	<u>Species</u>	<u>Framing</u>	<u>Board Lumber</u>

2.2 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](#).

2.2.1 Bolts, Nuts, Studs, and Rivets

[ASME B18.2.1](#), [ASME B18.5.2.1M](#), [ASME B18.5.2.2M](#) and [ASME B18.2.2](#).

2.2.2 Lag Screws and Lag Bolts

[ASME B18.2.1](#).

2.2.3 Nails

[ASTM F547](#), size and type best suited for purpose. In general, 8-penny or larger nails must be used for toe nailing [2 inch](#) thick lumber; 16-penny or larger nails must be used for nailing through [2 inch](#) thick lumber. Nails used with treated lumber and sheathing must be hot-dipped galvanized in accordance with [ASTM A153/A153M](#). Nailing must be in accordance with the recommended nailing schedule contained in [AWC WFCM](#). Where detailed nailing requirements are not specified, nail size and spacing must be sufficient to develop an adequate strength for the connection. The connection's strength must be verified against the nail capacity tables in [AWC NDS](#). Reasonable judgment backed by experience must ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector must be used.

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. Do not splice framing members between bearing points. Set joists, rafters, and purlins with their crown edge up. Provide adequate support as appropriate to the application, climate, and modulus of elasticity of the product. Provide as necessary for the proper completion of the work all framing members not indicated or specified. Spiking and nailing not indicated or specified otherwise must be in accordance with the Nailing Schedule contained in ICC IBC; perform bolting in an approved manner. Spikes, nails, and bolts must be drawn up tight.

3.2 MISCELLANEOUS

3.2.1 Wood Roof Nailers, Edge Strips, Crickets, Curbs, and Cants

Provide sizes and configurations indicated or specified and anchored securely to continuous construction.

3.2.1.1 Roof Edge Strips and Nailers

Provide at perimeter of roof, around openings through roof, and where roofs abut walls, curbs, and other vertical surfaces. Except where indicated otherwise, nailers must be 6 inches wide and the same thickness as the insulation. Anchor nailers securely to underlying construction. Anchor perimeter nailers in accordance with FM 4435.

3.2.2 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 framing members larger than 16 inches, and multiple offcuts of any size larger than 12 inches. Clearly separate damaged wood and other scrap lumber for acceptable alternative uses on site, including bracing, blocking, cripples, ties, and shims.

-- End of Section --

SECTION 06 61 16

SOLID SURFACING FABRICATIONS
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 NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z124 Plastic Plumbing Fixtures

ASTM INTERNATIONAL (ASTM)

ASTM D790 (2017) Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

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 D648 (2018) Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

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 D785 (2015) Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials

ASTM E84 (2020) Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM E228 (2017) Standard Test Method for Linear Thermal Expansion of Solid Materials with a Push-Rod Dilatometer

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

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2021; TIA 21-1) Life Safety Code

TILE COUNCIL OF NORTH AMERICA (TCNA)

TCNA Hdbk (2017) Handbook for Ceramic, Glass, and Stone Tile Installation

UNDERWRITERS LABORATORIES (UL)

UL 723 (2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials

UL 2824 (2020) GREENGUARD Certification Program Method for Measuring Microbial Resistance From Various Sources Using Static Environmental Chambers

1.2 SYSTEM DESCRIPTION

- a. Work under this section includes solid polymer (solid surfacing) countertop 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, shelving, 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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

Installation; G

SD-03 Product Data

Solid Polymer Material

Qualifications

Fabrications

Indoor air quality for solid surface seam and sealant products

SD-04 Samples

Material; G

Shower Wall Panel System

SD-06 Test Reports

Solid Polymer Material

SD-07 Certificates

Fabrications

Qualifications

Indoor Air Quality for solid surface fabrication products

SD-10 Operation and Maintenance Data

Clean-up

1.4 QUALITY ASSURANCE

1.4.1 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.

1.4.2 Mock-ups

Submit [Detail Drawings](#) indicating locations, dimensions, component sizes, fabrication and joint details, attachment provisions, installation details, and coordination requirements with adjacent work.

1.5 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.

1.6 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 [SS-1](#)

Provide cast, [non-pororous](#), 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	6000 psi (max.)	ASTM D638
Hardness	>85-Rockwell "M" scale(min.)	ASTM D785
Thermal Expansion	.000022 in/in/F (max.)	ASTM E228
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	144 inches, 1/2 lb ball, no failure	
Fungi and Bacteria	No growth	ASTM G21
Microbial Resistance	No growth	UL 2824
Flammability		ASTM E84
Flame Spread	<25	
Smoke Developed	<25	
Class	A	NFPA 101

2.1.2 SS-2

Provide cast, non-porous, 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	6000 psi (max.)	ASTM D638

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Hardness	65-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
Deflection Temperature	194 degrees fahrenheit	ASTM D648
Flextural Strength	8,407 psi	ASTM D638
Fungi Resistance	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	ASTM E84
Smoke Developed	<25	UL 723
Class	A	NFPA 101

2.1.3 Material Patterns and Colors

Provide patterns and colors for all solid polymer components and fabrications indicated on the project drawings. 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 matte; gloss rating of 5-20 for lighter colored solid surfacing and semi-gloss; gloss rating of 25-50 for darker colored solid surfacing as indicated on the drawings.

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 Conductive Tape

Provide manufacturer's standard conductive foil tape, [4 mils](#) thick, applied around the edges of cut outs containing hot or cold appliances.

2.2.6 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 Window Stools

Fabricate window stools from 1/2 inch thick solid surfacing, solid polymer material, including dimensions, edge shape, and other details as indicated on the drawings.

2.3.4 Shower Wall Panel System

Provide shower wall enclosures in a system of solid polymer components to include: panels corner trim, shower shelf panel edge trim. 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 shelves must be of a configuration, shape, and location as standard with the manufacturer's system.

2.3.4.1 Solid Surface Shower Base

Monolithic cast component of Solid surface Products polymer materials, composed of fully densified aluminum trihydrate mineral fillers, homogeneously blended in a engineered, UV stabilized acrylic modified polyester resin, minimum 36 x 36 inches. Shower receptor must have integrally molded support bracing on the bottom, positive sloped non-slip textured interior floor, and integral perimeter flange. Solid surface products shower receptors must incorporate, integral threshold and curb and 3 1/2 inches standard drain opening (for 2 inch No-Hub connection)

2.3.4.2 Shower Base Characteristics

Tensile Strength: 6,000 psi, when tested in accordance with ASTM D638
Flexural strength: 8,300 psi, when tested in accordance with ASTM D790
Modulus of Elasticity: 1.2 x 10 psi per ASTM D790
High Temperature Resistance: No Effect, when tested in accordance with ANSI/NEMA LD 3
Stain Resistance: Passes, when tested in accordance with ANSI Z124
Flame Spread: Class A, when tested in accordance with ASTM E84

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. 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 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.

3.1.3 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 07 05 23

PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS
08/19

PART 1 GENERAL

1.1 SUMMARY

Employ an independent agency to conduct the pressure test on the building envelope in accordance with this specification section and [ASTM E779](#).

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.

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-105	(2020) ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel
ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel
ASNT SNT-TC-1A	(2020) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

ASTM INTERNATIONAL (ASTM)

ASTM E779	(2019) Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
ASTM E1186	(2017) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
ASTM E1258	(1988; R 2018) Standard Test Method for Airflow Calibration of Fan Pressurization Devices
ASTM E1827	(2011; R 2017) Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 6781	(1983) Thermal Insulation - Qualitative Detection of Thermal Irregularities in Building Envelopes - Infrared Method
ISO 6781-2	(2010) Performance of Buildings - Detection of Heat, Air, and Moisture

Irregularities in Buildings by Infrared
Methods - Part2: Equipment Requirements

ISO 6781-3

(2015) Performance of Buildings -
Detection of Heat, Air, and Moisture
Irregularities in Buildings by Infrared
Methods - Part 3: Qualifications of
Equipment Operators, Data Analysts, and
Report Writers

1.3 DEFINITIONS

The following terms as they apply to this section:

1.3.1 Air Barrier Envelope

The surface that separates the inside air from the outside air. The combination of air barrier assemblies and air barrier components, connected by air barrier accessories are designed to provide a continuous barrier to the movement of air through an environmental separator. A single building may have more than one air barrier envelope. The air barrier surface includes the top, bottom, and sides of the envelope. The term "air barrier envelope" is also known as "air barrier system" or simply "air barrier".

1.3.2 Air Leakage Rate

How leaky, or conversely how air tight a building envelope is. The air leakage is normally described in terms of air flow rate for the surface area of the envelope at a defined differential pressure.

1.3.3 Bias Pressure

Also known as zero flow pressure, baseline pressure, offset pressure or background pressure. With the envelope not artificially pressurized, bias is the differential pressure that always exists between the envelope that has been prepared (sealed) for the pressure test and the outdoors. Bias pressure is made up of two components, fixed static offset (usually due to stack effect or the HVAC system) and fluctuating pressure (usually due to wind or a moving elevator). Because of pressure fluctuations many bias pressure readings are recorded and averaged for use in the calculations.

1.3.4 Blower Door

Commonly used term for an apparatus used to pressurize and depressurize the space within the building envelope and quantify air leakage through the envelope. The blower door typically includes a door fan and an air resistant fabric or a series of hard panels that extends to cover and seal the door opening between the fan shroud and door frame. The door fan is a calibrated fan capable of measuring air flow and is usually placed in the opening of an exterior door. With the air barrier otherwise sealed, air produced by the door fan pressurizes or de-pressurizes the envelope, depending on the fan's orientation.

1.3.5 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. The term "environmental

separator" is also known as the "control layer".

1.3.6 Pressure Test

A generic term for a test in which the envelope is either pressurized or de-pressurized with respect to the outdoors.

1.3.6.1 Negative Pressure Test (Depressurization Test)

A test wherein air inside the envelope is drawn to the outdoors. This places the envelope at a lower (negative) pressure with respect to the outdoors.

1.3.6.2 Positive Pressure Test (Pressurization Test)

A test wherein outdoor air is pushed into the envelope. This air movement places the envelope at a higher (positive) pressure with respect to the outdoors.

1.4 WORK PLAN

Submit the following after contract award, but before start of pressure testing work, steps to be taken by the lead pressure test technician to accomplish the required testing.

a. Memorandum of test procedure.

- (1) Proposed dates for conducting the pressure, thermographic and fog tests.
- (2) Submit detailed pressure test procedures prior to the test.
Provide a plan view showing proposed locations (personnel doors or other similar openings) to install blower doors or flexible ducts (for trailer-mounted fans), if used.

b. Test equipment to be used.

c. Scaffolding, scissor lifts, power, electrical extension cords, duct tape, plastic sheeting and other Contractor's support equipment required to perform all tests.

d. Other Contractor's support personnel who will be on site for testing.

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 Contractor Quality Control approval.. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan; G

SD-03 Product Data

Thermal Imaging Camera; G

SD-05 Design Data

Envelope Surface Area Calculations; G

SD-07 Certificates

Pressure Test Agency

Thermographer Qualifications

Test Instruments

Date Of Last Calibration

SD-06 Test Reports

Pressure Test Procedures; G

Air Leakage Test Report; G

Diagnostic Test Report; G

1.6 QUALITY ASSURANCE

1.6.1 Modification of References

Perform all pressure and diagnostic tests according to the referenced publications listed in paragraph REFERENCES and as modified by this section. Consider the advisory or recommended provisions, of the referred references, as mandatory.

1.6.2 Qualifications

1.6.2.1 Pressure Test Agency

Submit, information certifying that the pressure test agency is not affiliated with any other company participating in work on this contract. The work of the test agency is limited to pressure testing the building envelope, performing a thermography test and fog test, and investigating, through various methods, the location of air leaks through the air barrier. See paragraph PRESSURE TEST AGENCY for additional requirements. For thermographer qualifications, see paragraph THERMOGRAPHER QUALIFICATIONS.

Use the sample TEST AGENCY QUALIFICATIONS SHEET form (Appendix C), to submit the following information.

- a. Verification of 2 years of experience as an agency in pressure testing commercial and/or industrial buildings.
- b. List of at least ten commercial/industrial facilities with building envelopes that the agency has tested within the past 2 years. Include building name, address, and name of prime construction contractor and contractor's point-of-contact information.
- c. Confirmation of 2 years of commercial and or industrial building pressure test experience for the lead pressure test technician and the thermographer in using the specified ASTM E779 testing standard. References from five Contracting Officers for facilities where the lead test technician has supervised commercial and or industrial

building pressure tests in the last 2 years.

- d. Verification that the lead pressure test technician has been employed by a building pressure testing agency in the capacity of a lead pressure test technician for not less than 1 year.

1.6.2.2 Thermographer Qualifications

To perform an infrared diagnostic evaluation, use a lead thermographer who has at least an active Level II Certification that is based on the requirements in [ANSI/ASNT CP-105](#) or [ANSI/ASNT CP-189](#) and is in accordance with [ASNT SNT-TC-1A](#). The course of study is to be specifically focused on infrared thermography for building science. The thermographer must have at least two years of building science thermography experience in IR testing commercial or industrial buildings. The thermographer must also have experience in building envelopes and building science in order to make effective recommendations to the contractor should the envelope require additional sealing. Thermographic equipment operators, data analysts and report writers must comply with the requirements of [ISO 6781-3](#). Submit the thermographer's certificate for approval. Submit a list of at least ten commercial/industrial buildings on which the thermographer has performed IR thermography in the past two years. The thermographer is to have a current active certification.

1.6.3 Test Instruments and Date of Last Calibration

Submit a signed and dated list of test instruments, their application, manufacturer, model, serial number, range of operation, accuracy and date of most recent calibration. Calibration data applicable to fan systems must be in accordance with [ASTM E1258](#).

1.6.4 Test Reports

Submit electronic copies of an organized report. The report is to contain a table of contents, an executive summary, an introduction, a results section and a discussion of the results. Submit the [air leakage test report](#) as described in paragraph AIR LEAKAGE TEST REPORT. Submit a [diagnostic test report](#) as described in paragraph LOCATING LEAKS BY DIAGNOSTIC TESTING. The diagnostic test report is to include the Thermographic Investigation Report and the Fog Test Report (if performed).

Submit field data and completed report forms found in the appendices. Use the sample forms, Test Agency Qualification Sheet, Air Leakage Test Form and Air Leakage Test Results Form to summarize the tests for the appropriate building envelope. Submit both electronically populated and field hand filled-in forms.

Report Data. Include in the report the following information for all tests:

- a. Date of issue
- b. Project title and number
- c. Name, address, and telephone number of testing agency
- d. Dates and locations of samples and tests or inspections
- e. Names of individuals making the inspection or test

- f. Designation of the work and test method
- g. Identification of product and specification section
- h. Complete inspection or test data
- i. Test results and an interpretation of test results
- j. Comments or professional opinion on whether inspected or tested work complies with contract document requirements
- k. Recommendations on retesting

1.7 CLIMATE CONDITIONS SUITABLE FOR A PRESSURE TEST

As the test date approaches, monitor the weather forecast for the test site. Avoid testing on days forecast to experience high winds, rain, or snow. Monitor weather forecasts prior to shipping pressure test equipment to the site. Based on current and forecast weather conditions, the Contracting Officer's representative is to grant final approval for testing to occur.

1.7.1 Rain

For safety reasons, avoid testing during rain or if rain is anticipated during testing. If pneumatic hoses are installed and exposed to rain inspect the hose to insure rainwater has not migrated into the hose ends. Orient all exposed hose ends to keep them out of water puddles. Success in temporarily sealing outdoor ventilation components such as louvers and exhaust fans may also be compromised by rain. Don't seal roof-mounted ventilation components during times of potential lightning.

1.7.2 Wind

Because wind can skew pressure test results, test only on days and at times when winds are anticipated to be the calmest. Avoid pressure testing during gusty or high wind conditions. Avoid installing test fans on the windward side of the building if wind gusts during the test are anticipated to be greater than 10 miles per hour.

PART 2 PRODUCTS

2.1 PRESSURE TEST EQUIPMENT

Depending on site conditions and size of the envelope, the test may be conducted using blower door equipment. The testing agency is to supply sufficient quantity of blower equipment that will produce a minimum of 75 Pa differential pressure between the envelope and outdoors using the test methods described herein. Supplying additional blower test equipment to provide additional airflow capacity or to act as a backup is highly recommended.

2.1.1 Blower Door Fans

Each air flow measuring system including blower door fans is to be calibrated within the last 5 years. Calibrated blower door fans must measure accurately to within plus or minus 5 percent of the flow reading. Blower door equipment is to be specifically designed to pressurize

building envelopes. Each set of blower door equipment is to include fan(s), digital gage(s), door frame, door fabric or hard panels.

2.1.2 Digital Gages as Test Instruments

Use only digital gages as measuring instruments in the pressure test; analog gages are not acceptable. The gauges must be accurate to within 1.0 percent of the pressure reading or 0.15 Pa, whichever is greater. Each gage is to have been calibrated within two years of the test. The calibration is to be checked against a National Institute of Standards and Technology (NIST, formerly National Bureau of Standards) traceable standard.

2.2 THERMAL IMAGING CAMERA REQUIREMENTS

The thermal imaging camera used in the thermography test must have a thermal sensitivity (Noise Equivalent Temperature Difference.) of +/- 0.18 degrees F at 86 degrees F or less. Ensure the camera's operating spectral range falls between 2 and 15 micrometers. Ensure the camera's IR image viewing screen resolution measures at least 320x240 pixels. Ensure the camera has a means of recording thermal images seen on the camera viewing screen. The camera is to display output as individual still frame images that also can be downloaded and inserted into an electronic Thermographic Investigation Report. All thermographic equipment must comply with the requirements of ISO 6781-2. Submit camera make and model, and catalog information that defines the camera thermal sensitivity for approval.

PART 3 EXECUTION

3.1 PRESSURE TEST AGENCY

The test agency is to be an independent third party subcontractor, not an affiliated or subsidiary of the prime contractor, subcontractors or A/E firm. The agency is to be regularly engaged in pressure testing of commercial/industrial building envelopes. If using blower doors, the lead test technician must have at least two years of experience in using such equipment in building envelope pressurization tests. Formal training using pressure test equipment is highly recommended. Do not use the building's air handling system for pressure testing.

3.1.1 Field Work

The lead pressure test technician and thermographer are to be present at the project site while testing is performed and is to be responsible for conducting, supervising, and managing of their respective test work. Management includes health and safety of test agency employees.

3.1.2 Reporting Work

The lead pressure test technician is to prepare, sign, and date the test agenda, equipment list, and submit a certified Air Leakage Test Report. The thermographer is to prepare, sign, and date the test agenda, equipment list, and submit a certified Thermographic Investigation Report. The contractor is to prepare a final report that identifies improvements that were made to the envelope to reduce air leaks, mitigate thermal bridging, eliminate moisture migration,, and repair insulation voids discovered during diagnostic tests. Jointly submit all reports.

3.2 ENVELOPE SURFACE AREA CALCULATION

The architectural air barrier boundary includes the floor, walls, and ceiling. After construction of the air barrier envelope is complete, field measure the envelope to ensure the physical measurements match the design drawings and the air barrier envelope surface area calculations are generated. If the calculation result is not within 10 percent of the defined air barrier boundary calculation result as indicated, submit the envelope surface area calculation and results for review. If the air barrier was defined during design but the air barrier envelope surface area was not calculated, calculate it during construction and submit the [envelope surface area calculations](#) and result for review.

3.3 PREPARING THE BUILDING ENVELOPE FOR THE PRESSURE TEST

3.3.1 Testing During Construction

The pressure test cannot be conducted until all components of the air barrier system have been installed. After all sealing as described herein has been completed, inspect the envelope to ensure it has been adequately prepared. During the pressure test, stop all ongoing construction within and neighboring the envelope which may impact the test or the air barrier integrity. The pressure test may be conducted before finishes that are not part of the air barrier envelope have been installed. For example, if suspended ceiling tile, interior gypsum board or cladding systems are not part of the air barrier the test can be conducted before they are installed. Recommend testing prior to installing the finished ceilings within the envelope and immediately surrounding it. The absence of finished ceilings allows for inspection and diagnostic testing of the roof/wall interface and for implementation of repairs to the air barrier, if necessary to comply with the maximum allowed leakage.

3.3.2 Sealing the Air Barrier Envelope

Seal all penetrations through the air barrier. Unavoidable penetrations due to electrical boxes or conduit, plumbing, and other assemblies that are not air tight are to be made so by sealing the assembly and the interface between the assembly and the air barrier or by extending the air barrier over the assembly. Support the air barrier so as to withstand the maximum positive and negative air pressure to be placed on the building without displacement or damage, and transfer the load to the structure. Durably construct the air barrier to last the anticipated service life of the assembly and to withstand the maximum positive and negative pressures placed on it during pressure testing. Do not install lighting fixtures that are equipped with ventilation holes through the air barrier.

3.3.3 Sealing Plumbing

Prime all plumbing traps located within the envelope full of water.

3.3.4 Close and Lock Doors

Close and lock all doors and windows in the envelope perimeter. For doors not equipped with latching hardware, temporarily secure them in the closed position. Secure the doors in such a way that they remain fully closed even when the maximum anticipated differential air pressure produced during the test acts on them.

3.3.5 Hold Excluded Building Areas at the Outdoor Pressure Level

Keep building areas immediately surrounding but excluded from the test envelope at the outdoor pressure level during the pressure test. Maintain these areas at the outdoor pressure level by propping exterior doors open, opening windows and de-energizing all air moving devices in or serving these areas.

3.3.6 Maintain an Even Pressure within the Envelope

Ensure the pressure differences within the envelope are minimized by opening all internal air pathways including propping open all interior doors. Distribute test fans throughout the envelope as necessary to ensure the internal pressures are uniform (within 10 percent of the average differential pressure). Ideally, do not install suspended ceilings until after all pressure tests have been completed. If, however the envelope includes finished suspended ceiling spaces, temporarily remove approximately 5 percent of all ceiling tiles or a minimum of 1 tile from each isolated suspended ceiling space, whichever comprises the greatest surface area. Temporarily remove additional ceiling tiles during testing to allow for inspection and diagnostic testing of the ceiling/wall interface. An alternative to removing ceiling tiles is to measure the differential pressure between each isolated suspended ceiling space and the outdoors when the area below the suspended ceiling is maintained at a differential pressure of 75 Pa with respect to the outdoors. If the suspended ceiling differential pressure measurement is within ten percent of the 75 Pa pressure below the suspended ceiling no ceiling tiles need to be removed.

3.3.7 Maintain Access to Mechanical and Electrical Rooms

Maintain access to mechanical rooms and electrical rooms associated with the envelope to allow for de-energizing ventilation equipment and resetting circuit breakers tripped by blower door equipment, if used.

3.3.8 Minimize Potential for Blowing Dust and Debris

Because high velocity air will be blown into and out of the envelope during the test, debris, including dust and litter, may become airborne. Airborne debris may become trapped or entangled in test equipment, thereby skewing test results. Ensure areas within and surrounding the envelope are free of dust, litter and construction materials that are easily airborne. If pressurizing existing, occupied areas, provide adequate notice to building occupants of blowing dust and debris, and general disruption of normal activities during the test.

3.3.9 De-energize Air Moving Devices

De-energize all air moving devices serving the envelope to keep air within the envelope as still as reasonably achievable. De-energize all fans that deliver air to, exhaust air from, or recirculate air within the envelope. Also de-energize all fans serving areas adjacent to but excluded from the envelope.

3.3.10 Installing Blower Door Equipment in a Door Opening

Where blower door fans are used, before installing blower door equipment, select a door opening that does not restrict air flow into and out of the envelope and has at least 5 feet clear distance in front of and behind the

door opening. Disconnect the door actuator and secure the door open to prevent it from being drawn into the fan by fan pressure. Avoid installing blower door equipment on the windward side of the building.

3.4 BUILDING ENVELOPE AIR TIGHTNESS REQUIREMENT

For each building envelope, perform the Architectural Only test. The purpose of the pressure (air leakage) test is to determine final compliance with the airtightness requirement by demonstrating the performance of the continuous air barrier. An effective air barrier envelope minimizes infiltration and exfiltration through unintended air paths (leaks). The tests may be performed in any desired order.

3.4.1 Architectural Only Test

The test envelope is the architectural air barrier boundary as defined on the contract drawings. This boundary includes connecting walls, roof and floor which comprise a complete, whole, and continuous three dimensional envelope. Perform both a positive pressure test and a negative pressure test on this envelope, unless otherwise directed.

3.4.1.1 Test Goal

Input data from the test into the Air Leakage Rate by Fan Pressurization spreadsheet as described in paragraph CALCULATION PROGRAM via the Air Leakage Test Form. Compare output from the spreadsheet against the maximum allowable leakage defined in Section 07 27 10.00 10 BUILDING AIR BARRIER SYSTEM. The envelope passes the test if the leakage rate, as calculated using the spreadsheet, is equal to or lower than the Architectural Only leakage rate goal.

3.4.1.2 Preparing the Envelope for the Pressure Test - Seal All Openings through the Air Barrier

Temporarily close all perimeter windows, roof hatches and doors in the envelope perimeter except for those doors that are to remain open to accommodate blower door or trailer mounted fan test equipment installation. Seal, or isolate all other intentional openings, pathways and fenestrations through the architectural envelope prior to pressure testing. Follow the Recommended Test Envelope Conditions identified in ASTM E1827, Table 1, for the Closed Envelope condition. These openings may include boiler flues, fuel-burning water heater flues, fuel-burning kitchen equipment, clothes dryer vents, fireplaces, wall or ceiling grilles, diffusers etc. Before sealing flues, close their associated fuel valves and verify the associated pilot lights are extinguished. Prime all plumbing traps located within the envelope full of water. In lieu of applying tape and/or plastic, typical temporary sealing materials include tape and sheet plastic or a self-adhesive grille wrap. Use and apply tape and plastic in a manner that does not deface or remove paint or mar the finish of permanent surfaces. Be especially aware of residue that remains from tape applied to stainless steel surfaces such as kitchen hoods or rollup doors. For painted surfaces, use tape types that do not remove finish paint when the tape is removed. If paint is removed from the finished surface, repaint to match existing surfaces. Secure dampers closed either manually or by using the building's HVAC system controls. Use the table below for further guidance in building preparation.

Building Component	Envelope Condition
Air handling units, duct fans	As found (open) or temporarily sealed as necessary
Dampers - intake, exhaust	Physically closed or closed using control power or temporarily sealed
Diffusers, registers, grilles within the envelope	Temporarily sealed
Doors, personnel type, at the envelope perimeter	Secured closed
Doors, personnel type, within the envelope	Secured (propped) open
Doors, roll-up type, at the envelope perimeter	Closed (no additional sealing)
Windows	Secured closed

3.5 CONDUCTING THE PRESSURE TEST

Notify the Contracting Officer at least 10 working days before conducting the pressure tests to provide the Government the opportunity to witness the tests and to monitor weather forecasts for conditions favorable for testing. Do not pressure test until verifying that the continuous air barrier is in place and installed without failures in accordance with installation instructions. During the pressure test periodically inspect temporarily sealed items to ensure they are still sealed. Seals on temporarily sealed items tend to release more readily at higher pressures. Test data obtained after temporarily sealed items become unsealed cannot be used as input into the calculation program. Follow the Envelope Pressure Test Procedures in the paragraphs below. Submit detailed [pressure test procedures](#) indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed for the building envelope pressure (air tightness) test. Submit these procedures not later than 60 days after Notice to Proceed.

3.5.1 Extend Pneumatic Tubes and Establish a Reference Differential Pressure

Confirm the various zones within the envelope have a relatively uniform interior pressure distribution by establishing a representative differential pressure between the envelope and the outdoors with blower door fans operating. The number of indoor pressure difference measurements (pneumatic hoses) required depends on the number of interior zones separated by bottle necks that could create significant pressure drops (e.g. doorways and stairwells). Extend at least four pneumatic hoses (differential pressure monitoring ports) to locations within the envelope that are physically opposite of each other. Locate the hose ends away from the effects of air discharge from blower test equipment. Select one of the four (or more) interior hoses, one judged by the test agency to be the most unaffected by air velocity produced by blower test equipment, to serve as the interior reference pressure port. Extend at least one additional pneumatic hose to the outdoors (outdoor pressure port). To the end of this hose manifold at least four hoses together and terminate each hose on a different side of the building. With the envelope sealed and the blowers energized, measure the differential pressure using the interior reference pressure port and the four outdoor pressure ports. Then measure and record the differential pressure by individually using each of the remaining three interior hoses. Ensure each reading is within plus or minus 10 percent of the reference reading. Thus at an average 75 Pa maximum pressure difference across the envelope, the difference between the highest and lowest interior pressure difference measurements should be 15 Pa or less. If this condition cannot be met, attempt to create additional air pathways within the envelope to minimize pressure differences within the envelope. If necessary, move the interior hose ends. See step 2.13 of the Air Leakage Test Form in Appendix A.

3.5.2 Bias Pressure Readings

With the fan pressurization equipment de-energized and the envelope sealed, obtain the differential pressure between the outdoors and the envelope. Record 12 bias pressure readings before the pressure test and 12 bias pressure readings after the pressure test. Each reading is the average of ten or more 1-second measurements. Include positive and negative signs for each reading. To help dampen bias pressures that significantly contribute to test pressure, reduce temperature differences between indoor and outdoor air. Temperature differences can be reduced by operating test fan equipment for a few minutes to replace most of the indoor air with outdoor air.

3.5.3 Testing in Both Positive and Negative Directions

The preferred method for testing a building envelope is to test in both the pressurized and depressurized directions. Testing in one direction is only allowed if opposite direction testing cannot logistically be performed due to test equipment limitations or restrictions. After obtaining the pre-test bias differential pressure readings, conduct the pressure test. Record the envelope pressures (in units of Pascals) from one interior pneumatic hose (monitoring port) and the outdoor pneumatic hose(s), averaged or manifolded, with corresponding flows (in units of cfm) for each fan. Record the flow rates at at least 10 to 12 positive and 10 to 12 negative building pressure readings. If conducting both positive and negative pressure tests the lowest allowable test pressure is 40 Pa and the highest test pressure is 85 Pa. Keep at least 25 Pa difference between the lowest and highest test pressure readings. Include the 75 Pa

pressure value between the lowest and highest readings. The 10 to 12 readings in each direction are to be roughly evenly spaced along the range of pressures and flows. After testing is complete de-energize the equipment used to provide pressurization and obtain an additional 10 to 12 post-test bias pressure readings. None of the bias pressure readings are allowed to exceed 30 percent of the minimum test pressure. If these limits are exceeded the test fails and must be repeated.

3.5.4 Pressure Testing - Special Cases

3.5.4.1 Pressure Testing a Building Addition

If the existing building is occupied, coordinate the pressure test with building representatives. In preparation of the test, de-energize the air handling system serving that portion of the existing building that shares surfaces with the new building addition. Pressure testing a new building addition may also require pressurizing that part of the existing building that shares surfaces in common with the new building addition. If an air barrier is applied to the common surfaces separating the existing building from the new addition, prior to the test prop open a sufficient quantity of doors and/or windows to keep the existing building at the same pressure as the outdoors. If an air barrier is not applied to the common surfaces separating the existing building from the new addition, pressurize that part of the existing building that shares surfaces in common with the building addition to the same level as the addition using separate test pressurization equipment.

3.5.5 Failed Pressure Test

If the pressure test fails to meet the established criteria, use diagnostic test methods described in paragraph LOCATING LEAKS BY DIAGNOSTIC TESTING to discover the leak locations. Provide additional permanent sealing measures to reduce or eliminate leak sources discovered during diagnostic testing. Retest (perform another pressure test) after sealing has been completed. Repeat this sequence of documenting test results in the test report, performing diagnostic tests, documenting recommendations for additional sealing measures in the test report, sealing leak locations per recommendations, and re-testing as necessary until the building envelope passes the pressure test and is in compliance with the performance requirements.

3.5.6 Air Leakage Test Report

Report volumetric flow rates and corresponding differential pressures in [cubic feet per minute \(cfm\)](#) and Pascals (Pa), respectively, on the Air Leakage Test Form sample form found in Appendix A. Populate the accompanying spreadsheet file entitled Pressure Test Data Analysis with information obtained during the test. The spreadsheet uses equations found in [ASTM E779](#) as a basis for calculating the envelope leakage rate. Other similar leakage rate calculation programs cannot be used or submitted for review. Submit a printout of the data input and output in the report. Should any air tightness (pressure) test fail, the pressure test report is to include data and results from all previous failed tests along with the final successful test data and results. Indicate if the resulting leakage rate did or did not meet the goal leakage requirement. Identify and document deficiencies in the building construction upon failure of a test to meet the specified maximum leakage rate.

Include the Test Agency Qualification Sheet, Air Leakage Test Form and Air

Leakage Test Results Form in the written report. Document every test set-up condition with diagrams and photos to ensure the tests can be made repeatable. Document all pneumatic hose termination locations. Record in detail how the building envelope was prepared for the tests. Also describe in detail which building items were temporarily sealed. Include photos of test equipment and sealing measures in the report. Include an electronic (pdf) version of all test reports on a CD. If the building envelope fails to meet the leakage rate goal, provide recommendations to further seal the envelope and document these recommendations in the test report.

3.6 LOCATING LEAKS BY DIAGNOSTIC TESTING

Use diagnostic test methods described herein to discover obvious leaks through the envelope. Perform diagnostic tests on the building envelope regardless of the envelope meeting or failing to meet the designated leakage rate goal. Use diagnostic test methods in accordance with [ASTM E1186](#) and in conjunction with pressurization equipment as necessary. Use the thermography diagnostic test to establish a baseline for envelope leakage. Apply additional diagnostic tests (find, feel, fog or other tests) as necessary to further define leak locations and pathways discovered using thermography or to find additional leaks not readily detected by thermography. Using a variety of diagnostic tests may help locate leaks that would otherwise go undetected if only a single diagnostic test were used. Pay special attention to locating leaks at interfaces where there is a change in materials or a change in direction of like materials. These interfaces, at a minimum, include roof/wall, wall/wall, floor/wall, wall/window, wall/door, wall/louver, roof mounted equipment/roof curb interfaces and all utility penetrations (ducts, pipes, conduit, etc) through the envelope's architecture. Also use diagnostic tests to check for leakage between the air duct and duct damper, when the damper, under normal control power, is placed in the closed position. Should leaks be discovered during diagnostic tests, thoroughly document their exact locations on a floor plan so that sealing can be later applied, if required or as directed. If the envelope passes the leakage test, use the diagnostic test procedure described above to identify obvious leakage locations. Seal the leaks at the discretion of the COR based on the magnitude, location, potential for liquid moisture penetration or retention, potential for condensation, presence of daylight through an architectural surface or if the leakage location could potentially cause rapid deterioration or mold growth of, or in the building envelope materials and assemblies. Apply sealing measures after diagnostic testing is complete and all pressurization blowers are off. To verify that the applied sealing measures that are effective, re-test for leaks using the same diagnostic methods that discovered the leak. Reseal and retest until the envelope meets the leakage rate goal and all obvious leaks through the envelope are sealed.

3.6.1 Find Test

Use visual observation to locate daylight and/or artificial light streaming from the opposite side of the envelope. Observe all interfaces identified above.

3.6.2 Feel Test

Use the building's air handling system or blower door equipment to negatively pressurize the building envelope, to at least 25 Pa but no greater than 85 Pa, with respect to the outdoors. The larger the pressure

difference, the easier discovering leaks by feeling them becomes. While inside the envelope, hand feel roof/wall, wall/wall, and floor/wall interfaces and utility penetrations (ducts, pipes, conduit, etc) for leaks and note the leak locations on a floor plan. The "Feel" test may also be used to check for leaks between the ductwork and ductwork damper. To do this, positively pressurize the envelope and check for air movement from the envelope exterior.

3.6.3 Infrared Thermography Test

Avoid performing thermography tests just after pressure testing the building envelope (pressurizing and/or depressurizing the building envelope) as thermography readings may be inaccurate due to excessive air-wash. Perform thermography either before the pressure test or wait an appropriate amount of time after pressure test completion for the temperatures within the building envelope to stabilize before starting the thermography tests. Coordinate thermography examination with the pressure test agency and the test agency's pressurization equipment. The pressure test agency is to allow adequate time for the thermographer to perform a complete thermographic examination, as described hereinafter, of the envelope interior and exterior.

3.6.3.1 Thermography Test Methods

Before thermographic testing, remove furniture, construction equipment, and all other obstructions both inside and outside the building as necessary to gain a clear field of view. In the Thermographic Investigation Report, document all areas where obstructions remain. For exterior thermal examination of the envelope, verify that no direct solar radiation has heated the envelope surfaces to be examined for a period of approximately 3 hours for frame construction and for approximately 8 hours for masonry veneer construction. Conduct exterior investigations after sunset, before sunrise, or on an overcast day when the influence of solar radiation can be determined to be minimal. Limit exterior examinations to times when the influence of solar radiation is minimal, such as after sunset or before sunrise or during an overcast day. Conduct thermal imaging tests only when wind speeds are less than 8 mph at the time of analysis and at the end of analysis. Document any variations in wind during the test. Document all variations of test conditions in the Thermographic Investigation Report. Test only when exterior surfaces are dry. Monitor and document ongoing test parameters, such as the temperatures inside and outside the air barrier envelope, wind speed, and differential pressure.

3.6.3.1.1 Thermography Testing of the Air Barrier

Test the building envelope in accordance with [ISO 6781](#), and [ASTM E1186](#). Perform a complete thermographic inspection consisting of the full inspection of the interior and exterior of the complete air barrier envelope. Document envelope areas that are inaccessible for testing. Use infrared thermography technology in concert with standard pressurization methods (blower doors, trailer mounted fans and/or the building's own air handling systems) to locate leaks through the air barrier. Because thermography works best with at least a [18 degree F](#) temperature difference between the envelope interior and the exterior, adjust the HVAC system, if possible, to create or enhance this temperature difference. The minimum allowable temperature difference is [3 degrees F](#). Maintain this temperature difference for at least 3 hours prior to the test. Use pressurization methods to establish a minimum of +20 Pa pressure

difference with respect to the outdoors while using an infrared camera to view the envelope from outdoors. When viewing with the camera from inside the envelope, keep the envelope at a pressure differential of -20 Pa with respect to the outdoors using pressure testing equipment or the building's own air handling system.

3.6.3.2 Thermography Test Results

Document the location of all leaks, anomalies, and unusual thermal features on a floor plan and/or elevation view and catalog them with a visible light picture for locating the defect for correction. The thermographer is to recommend corrective actions to eliminate the leaks, anomalies and unusual thermal features. Where leaks are found perform corrective sealing as necessary to achieve the whole envelope air leakage rate specified. After sealing, again use thermography in concert with standard pressurization methods to verify that the air leakage has been reduced. After these leaks have been permanently sealed note all actions taken on the drawings or in the Thermographic Investigation Report. Submit the drawings for approval as part of the Thermographic Investigation Report. Also include thermographic photos that show where leaks were discovered. Include thermograms using an imaging palette that clearly shows the observed thermal patterns indicating air leakage. The Contracting Officer's Representative is to witness all testing.

3.6.4 Fog Test

Before using a theatrical fog generator, disable all building smoke detectors as they may alarm when fog is issued. Coordinate fog tests and the disabling of all smoke detectors with the Contracting Officer's representative and the local fire department as necessary. Use pressure test equipment or the buildings own air handling system to positively pressurize the building envelope to at least 25 Pa but not greater than 85 Pa over the outdoors. Using a theatrical fog generator within the envelope, direct fog at suspected leakage points such as at building interfaces. Test the following interfaces: roof/wall, wall/wall, floor/wall, wall/window, roof/mounted mechanical equipment. From the vantage point immediately outside the envelope and opposite that of the interface being tested, observe the effect as the fog is issued. Detection may also be further enhanced by using a scented fog liquid or a fog liquid that produces a colored fog. Look for fog and smell for associated odor percolating through the interface. Also use smoke puffers and smoke sticks as necessary to locate leaks at these and other interface locations. If the Architectural Plus HVAC System pressure test will be/was performed introduce fog into ductwork to check for leakage between ductwork and associated dampers. After fog testing has ended, reactivate the building smoke detectors and notify the Contracting Officer and local fire department that the test has ended. After sealing has been completed retest these areas using fog. Seal additional leaks that are found.

3.6.5 Diagnostic Test Report

Once the diagnostic tests have been completed and the leakage locations identified and sealed, document these procedures, locations and recommendations in the diagnostic test report. Submit plan and/or profile drawings that thoroughly identify leak locations. Describe in detail all leak locations so that the seal-up crew knows where to apply sealing measures. After sealing measures have been applied, describe the methods used along with applicable photos of the final sealed condition.

3.6.5.1 Thermographic Investigation Report

Submit a report of each thermographic investigation identifying the thermal discontinuities in the thermal control layer. Indicate in the final report locations to which improvements for both the air control layer and the thermal control layer were made to reduce air leaks and correct discontinuities in the thermal control layer. Include in the report some selected radiometric images of suspected failure points in the air barrier envelope that indicate before and after conditions. Devote a chapter(s) of the Thermographic Investigation Report to identifying suspected points of thermal bridging, moisture migration through roofs and walls, and insulation voids. Indicate in the final report improvements that were made to the envelope to reduce air leaks. Include the following items in the report:

- a. Brief description of the building construction
- b. Types of interior and exterior surface materials used in the building.
- c. Geographical orientation of the building with a description of the exterior surroundings including other buildings, vegetation, landscaping, and surface water drainage.
- d. Camera brand, model and serial number, and date of most recent calibration date; optional lenses with serial numbers (if applicable)
- e. Thermographer's and Government Inspector's names
- f. Date and time of tests
- g. Air temperature and humidity inside the air barrier envelope
- h. Outdoor air temperature and humidity
- i. General information for the last 12 hours on the solar radiation conditions in the geographic area where the test is being performed.
- j. Ambient conditions such as precipitation and wind direction and speed occurring with the last 24 hours, as applicable. Refer to specific requirements in each section of each thermographic inspection type for requirements in each specific area.
- k. Documentation of those portions of the building envelop which were not within test conditions when the scan was performed and which portions were obstructed by adjacent structures, interior furnishings, intervening cavities or reflective surfaces.
- l. Other relevant information, which may have influenced test results.
- m. Drawings, sketches, floor plans and/or photographs detailing the locations in the buildings where thermograms were taken detailing possible irregularities in the components being tested.
- n. Thermal images taken during the inspection with their relative locations and written or voiced recorded explanations of the anomaly listed along with visual and reference images.
- o. An identification of the aspects or components of the building being examined.

- p. Explanations for the type and the extent of each construction defect observed during the inspection.
- q. Any results from additional measurements and investigations. Identify additional equipment used and support with type, model number, serial number and date of most recent calibrated.

3.6.5.2 Fog Test Report

Document all turbulent air flow and dead air spaces within the envelope. Report fog behavior as it exits from and/or is entrained within the building. Include a floor plan in the report that documents the locations where fog passed through the envelope.

3.7 CALCULATION PROGRAM

To calculate the envelope leakage rate and other required outputs, input the data obtained during the pressure tests as documented in the Air Leakage Test Form (Appendix A) into the Air Leakage Rate by Fan Pressurization Excel spreadsheet. This spreadsheet can be found at the following web site:

<http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphic>

3.8 AFTER COMPLETION OF THE PRESSURE AND/OR DIAGNOSTIC TEST

After all pressure and/or diagnostic testing has been completed unseal all temporarily sealed items. Unless otherwise directed by the Contracting Officer, return all dampers, doors, and windows to their pre-test condition. Remove tape and plastic from all temporarily sealed openings, being careful not to deface painted surfaces. If paint is removed from finished surfaces, repaint to match existing surfaces. Unless otherwise directed by the Contracting Officer's representative, return fuel (gas) valves to their pre-test position and relight pilot lights. Return all fans and air handling units to pre-test conditions.

3.9 REPAIR AND PROTECTION

Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for testing, inspection, and similar services. Upon completion of inspection, testing, or sample taking and similar services, repair damaged construction and restore substrates and finishes, protect construction exposed by or for quality control service activities, and protect repaired construction.

3.10 APPENDICES

The following forms are available for download as a MS Word file at

<http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphic>

Appendix A - Air Leakage Test Form

Appendix B - Air Leakage Test Results Form

Appendix C - Test Agency Qualifications Sheet

-- End of Section --

SECTION 07 21 13

BOARD AND BLOCK INSULATION

02/16, 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.

ASTM INTERNATIONAL (ASTM)

ASTM C272/C272M	(2016) Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions
ASTM C578	(2019) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C930	(2019) 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 E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2022) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2021) International Building Code
---------	------------------------------------

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's Standard Details; G

Block or Board Insulation; G

Accessories including sealants; G

Recycled Content for Block or Board Insulation; S

SD-07 Certificates

Block or Board Insulation; G

Protection Board or Coatings; G

Draft Special Warranties; G

Final Special Warranties; G

Indoor Air Quality For Block Or Board Insulation; S

SD-08 Manufacturer's Instructions

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 Other Safety Considerations

Comply with the safety requirements of [ASTM C930](#).

1.7 SPECIAL WARRANTIES

1.7.1 Guarantee

Guarantee insulation installation against failure due to ultraviolet light exposure for a period of three years from the date of Beneficial Occupancy or Substantial Completion. Submit draft and final guarantees in accordance with Sections [01 78 00](#) CLOSEOUT SUBMITTALS

1.7.2 Warranty

Provide manufacturer's material warranty for all system components for a period of three years from the date of Beneficial Occupancy or Substantial Completion. Submit draft and final warranties in accordance with Sections [01 78 00](#) CLOSEOUT SUBMITTALS.

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:

- a. Extruded Preformed Cellular Polystyrene: [ASTM C578](#) REV A

2.1.1 Thermal Resistance

Unless otherwise indicated, Wall R-[15](#) R-.

2.1.2 Fire Protection Requirements

- a. Flame spread index of 75 or less when tested in accordance with [ASTM E84](#).
- b. Smoke developed index of [200](#) or less when tested in accordance with [ASTM E84](#).
- c. Provide insulated assemblies in accordance [ICC IBC](#) Chapter Fire and Smoke Protection Features.

2.1.3 Other Material Properties

Provide thermal insulating materials with the following properties:

- a. Rigid cellular plastics: Compressive Resistance at Yield: Not less than [25 pounds per square inch \(psi\)](#) when measured according to [ASTM D1621](#).
- b. Water Vapor Permeance: Not more than [1.5 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.

- c. Water Absorption: Not more than 2 percent by total immersion, by volume, when measured according to ASTM C272/C272M.

2.1.4 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:

Phenolic Rigid Foam:	5 percent

Provide data identifying percentage of recycled content for block or board insulation.

2.1.5 Indoor Air Quality

Provide certification of indoor air quality for block or board insulation.

2.1.6 Prohibited Materials

Do not provide materials containing asbestos.

2.2 ACCESSORIES

2.2.1 Adhesive

As recommended by insulation manufacturer.

2.2.2 Mechanical Fasteners

Corrosion resistant fasteners as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 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.

3.2 INSTALLATION

3.2.1 Installation and Handling

Provide insulation in accordance with the manufacturer's printed installation instructions. Keep material dry and free of extraneous materials.

3.2.2 Electrical Wiring

Do not install insulation in a manner that would enclose electrical wiring between two layers of insulation.

3.2.3 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.

3.2.4 Coordination

Verify final installed insulation thicknesses comply with thicknesses indicated, R-values specified herein, and with the approved insulation submittal(s).

3.3 INSTALLATION ON WALLS

3.3.1 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.

3.3.2 Adhesive Attachment to Concrete and Masonry Walls

Apply adhesive to wall and completely cover wall with insulation.

- a. Spot method: Provide at least six spots having diameter of approximately 4 inches, located at each corner and mid points of each of the longer sides of each board.
- b. Use only full back method for pieces of 1 square foot or less.

3.3.3 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.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 07 21 16

MINERAL FIBER BLANKET INSULATION

11/11, CHG 4: 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 C665 (2017) Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

ASTM C930 (2019) Standard Classification of Potential Health and Safety Concerns Associated with Thermal Insulation Materials and Accessories

ASTM D5359 (2015) Standard Specification for Glass Cullet Recovered from Waste for Use in Manufacture of Glass Fiber

ASTM E84 (2020) Standard Test Method for Surface Burning Characteristics of Building Materials

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SCS Global Services (SCS) Indoor Advantage

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134 Respiratory Protection

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Blanket Insulation

Recycled Content for Insulation Materials; S

Accessories

SD-07 Certificates

Indoor Air Quality for Insulation Materials; S

SD-08 Manufacturer's Instructions

Insulation

1.3 CERTIFICATIONS

Submit required indoor air quality certifications and validations in one submittal package.

1.3.1 Insulation Products

Provide product 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 from certification body.

1.3.2 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 herein.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials to 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.

1.4.2 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.

1.5 SAFETY PRECAUTIONS

1.5.1 Respirators

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by National Institute for Occupational

Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) in accordance with 29 CFR 1910.134.

1.5.2 Other Safety Concerns

Consider other safety concerns and measures as outlined in ASTM C930.

PART 2 PRODUCTS

2.1 Acoustical BLANKET INSULATION

ASTM C665, Type I, blankets without membrane coverings and a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84.

2.1.1 Thermal Resistance Value (R-VALUE)

The R-Value is 3 per inch.

2.1.2 Recycled Materials

Provide insulation materials containing the following minimum percentage of recycled material content by weight:

Fiberglass: 20 percent glass cullet complying with ASTM D5359

Provide data identifying percentage of recycled content for insulation materials.

2.1.3 Prohibited Materials

Do not provide asbestos-containing materials.

2.1.4 Reduced Volatile Organic Compounds (VOC) for Insulation Materials

Provide certification of indoor air quality for insulation materials.

2.2 Fire BLANKET INSULATION

Rated wall assembly sound attenuation fire blankets, or mineral wool, consists of inorganic fibers derived from basalt, bonded and formed to a thickness and a width corresponding to the stud spacing and cavity depth. Insulation complies with ASTM C 665, Type I and ASTM E 136, Non Combustible. Material has a density of 2.5 PCF, NRC of 1.2 for a 4 inch thickness, and an R-value of 3.7 per inch. When tested in accordance with ASTM E 84, material has a flame spread rating of 0 and smoke developed rating of 0.

2.3 ACCESSORIES

2.3.1 Mechanical Fasteners

Corrosion resistant fasteners as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Insulation

Install and handle insulation in accordance with manufacturer's instructions. Keep material dry and free of extraneous materials. Any materials that show visual evidence of biological growth due to presence of moisture must not be installed on the building project. Ensure personal protective clothing and respiratory equipment is used as required. Observe safe work practices.

Place insulation in permanent contact with the six surfaces that enclose each cavity, and provide a thickness and width corresponding to the cavity depth and shape. Specified insulation R-values are minimums. Provide greater thicknesses and R-values to fully fill cavities without compression.

3.1.1.1 Electrical wiring

Do not install insulation in a manner that would sandwich electrical wiring between two layers of insulation.

3.1.1.2 Continuity of Insulation

Install blanket insulation to butt tightly against adjoining blankets and to studs and any obstructions. Provide continuity and integrity of insulation at corners, and floor. Avoid creating thermal bridges.

3.1.1.3 Insulation without Affixed Vapor Retarder

Provide snug friction fit to hold insulation in place. Stuff pieces of insulation into cracks between trusses, joists, studs and other framing, such as at attic access doors, door and window heads, jambs, and sills, band joists, and headers.

3.1.1.4 Sizing of Blankets

Provide only full width blankets when insulating between studs. Size width of blankets for a snug fit where trusses, joists or studs are irregularly spaced.

-- End of Section --

SECTION 07 22 00

ROOF AND DECK INSULATION

02/16, CHG 3: 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.

ASTM INTERNATIONAL (ASTM)

ASTM C1289 (2022) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board

FM GLOBAL (FM)

FM 4450 (1989) Approval Standard for Class 1 Insulated Steel Deck Roofs

FM APP GUIDE (updated on-line) Approval Guide
<http://www.approvalguide.com/>

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 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Insulation Board Layout and Attachment; G

SD-03 Product Data

Insulation; G

Fasteners; G

Recycled Content For Insulation; S

SD-07 Certificates

Installer Qualifications; G

Indoor Air Quality For Insulation; S

SD-08 Manufacturer's Instructions

Nails and Fasteners; G

Roof Insulation; G

1.3 SHOP DRAWINGS

Submit [insulation board layout](#) and attachment indicating methods of attachment and spacing, transitions, tapered components, thicknesses of materials, and closure and termination conditions. Show locations of ridges, valleys, crickets, interface with, and slope to, roof drains. Show wood nailers..

1.4 PRODUCT DATA

Include data for material descriptions, recommendations for product shelf life, requirements for coatings, and precautions for flammability and toxicity. Include data to verify compatibility of sealants with insulation.

1.5 MANUFACTURER'S INSTRUCTIONS

Include field of roof and perimeter attachment requirements.

Provide a complete description of installation sequencing for each phase of the roofing system. Include weatherproofing procedures.

1.6 QUALITY CONTROL

Provide certification of [installer qualifications](#) from the insulation manufacturer confirming the specific installer has the required qualifications for installing the specific roof insulation system(s) indicated.

1.7 CERTIFICATIONS

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.

1.8 DELIVERY, STORAGE, AND HANDLING

1.8.1 Delivery

Deliver materials to the project site in manufacturer's unopened and undamaged standard commercial containers bearing the following legible information:

- a. Name of manufacturer
- b. Brand designation

- c. Specification number, type, and class, as applicable, where materials are covered by a referenced specification

Deliver materials in sufficient quantity to allow continuity of the work.

1.8.2 Storage and Handling

Store and handle materials in accordance with manufacturer's printed instructions. Protect from damage, exposure to open flame or other ignition sources, wetting, condensation, and moisture absorption. 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. Store in an enclosed building or trailer that provides a dry, adequately ventilated environment. Replace damaged material with new material.

1.9 ENVIRONMENTAL CONDITIONS

Do not install roof insulation during inclement weather or when air temperature is below 40 degrees F and interior humidity is 45 percent or greater, or when there is visible ice, frost, or moisture on the roof deck.

PART 2 PRODUCTS

2.1 INSULATION

2.1.1 Insulation Types

Provide one, or an assembly of a maximum of three, of the following roof insulation materials. Provide roof insulation that is compatible with attachment methods for the specified insulation and roof membrane.

- a. Polyisocyanurate Board: Provide in accordance with ASTM C1289 REV A Type II, fibrous felt or glass mat membrane both sides, except minimum compressive strength of 20 pounds per square inch (psi).

2.1.2 Recycled Materials

Provide thermal insulation materials containing recycled content. Unless specified otherwise, the minimum required recycled content for listed materials are:

Polyisocyanurate/polyurethane:	9 percent recovered material

Provide data identifying percentage of [recycled content for insulation](#).

2.1.3 Indoor Air Quality

Provide certification of [indoor air quality for insulation](#).

2.1.4 Insulation Thickness

As necessary to provide the thermal resistance (R-value) indicated. Base calculation on the R-value for aged insulation. For insulation over steel decks, satisfy both specified R-value and minimum thickness for width of rib opening recommended in insulation manufacturer's published literature.

2.2 FASTENERS

Provide flush-driven fasteners through flat round or hexagonal steel or plastic plates. Provide zinc-coated steel plates, flat round not less than [1 3/8 inch](#) diameter, hexagonal not less than [28 gage](#). Provide high-density plastic plates, molded thermoplastic with smooth top surface, reinforcing ribs and not less than [3 inches](#) in diameter. Fully recess fastener head into plastic plate after it is driven. Form plates to prevent dishing. Do not use bell or cup shaped plates. Provide fasteners in accordance with insulation manufacturer's recommendations for holding power when driven, or a minimum of [120 pounds](#) each in steel deck, whichever is the higher minimum. Provide fasteners for steel or concrete decks in accordance with [FM APP GUIDE](#) (<http://www.approvalguide.com/>) for Class I roof deck construction, and spaced to withstand uplift pressure of [55 pounds per square foot](#).

2.2.1 Fasteners for Steel Decks

Approved hardened penetrating fasteners or screws in accordance with [FM 4450](#) and listed in [FM APP GUIDE](#) for Class I roof deck construction. Quantity and placement to withstand a minimum uplift pressure of [55 psf](#) in accordance with [FM APP GUIDE](#).

2.3 WOOD NAILERS

Pressure-preservative treated as specified in Section [06 10 00](#) ROUGH CARPENTRY.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

3.1.1 Surface Inspection

Ensure surfaces are clean, smooth, and dry prior to application. Check roof deck surfaces, including surfaces sloped to roof drains and outlets, for defects before starting work.

The Contracting Officer will inspect and approve the surfaces immediately before starting installation. Prior to installing insulation, perform the following:

- a. Examine steel decks to ensure that panels are properly secured to structural members and to each other and that surfaces of top flanges are flat or slightly convex.

3.1.2 Surface Preparation

Correct defects and inaccuracies in roof deck surface to eliminate poor drainage from hollow or low spots, perform the following:

- a. Provide wood nailers of the same thickness as the insulation at eaves, edges, curbs, walls, and roof openings for securing gutters, and flashing flanges. On decks with slopes of one in 12 (1 inch per foot) or more, install wood nailers perpendicular to slope for securing insulation. Space nailers in accordance with approved shop drawings.
- d. Cover steel decks with a layer of insulation board of sufficient width to span the width of a deck rib opening, and in accordance with fire safety requirements. Secure with piercing or self-drilling, self-tapping fasteners of quantity and placement in accordance with FM APP GUIDE. Locate insulation joints parallel to ribs of deck on solid bearing surfaces only, not over open ribs.

3.2 INSULATION INSTALLATION

Apply insulation in two layers with staggered joints when total required thickness of insulation exceeds 1/2 inch. Lay insulation so that continuous longitudinal joints are perpendicular to direction of roofing and end joints of each course are staggered with those of adjoining courses. When using multiple layers of insulation, provide joints of each succeeding layer that are parallel and offset in both directions with respect to the layer below. Keep insulation 1/2 inch clear of vertical surfaces penetrating and projecting from roof surface.

3.2.1 Installation Using Only Mechanical Fasteners

Secure total thickness of insulation with penetrating type fasteners.

3.3 PROTECTION

3.3.1 Protection of Applied Insulation

Completely cover each day's installation of insulation with finished roofing. Phased construction is not permitted. Protect open spaces between insulation and parapets or other walls and spaces at curbs, scuttles, and expansion joints, until permanent roofing and flashing are applied. Storing, walking, wheeling, or trucking directly on insulation or on roofed surfaces is not permitted. Provide smooth, clean board or plank walkways, runways, and platforms near supports, as necessary, to distribute weight. Protect exposed edges of insulation with cutoffs at the end of each work day or whenever precipitation is imminent. Cutoffs must be single ply membrane set in roof cement. Fill all profile voids in

cutoffs to prevent trapping moisture below the membrane. Remove cutoffs when work resumes.

3.3.2 Damaged Work and Materials

Restore work and materials that become damaged during construction to original condition or replace with new materials.

3.4 INSPECTION

Establish and maintain inspection procedures to assure compliance of the installed roof insulation with contract requirements. Remove, replace, correct in an approved manner, any work found not in compliance. Quality control must include, but is not limited to, the following:

- a. Observation of environmental conditions; number and skill level of insulation workers; start and end time of work.
- b. Inspection of mechanical fasteners; type, number, length, and spacing.
- c. Inspection of insulation joint orientation and laps between layers, joint width and bearing of edges of insulation on deck.
- d. Installation of cutoffs and proper joining of work on subsequent days.
- e. Continuation of complete roofing system installation to cover insulation installed same day.

-- End of Section --

SECTION 07 27 10.00 10

BUILDING AIR BARRIER SYSTEM

08/19, CHG 1: 02/20

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.

This section also defines the maximum allowable leakage of the final air barrier system. The workmanship must be adequate to meet the maximum allowable leakage requirements of this specification. Test the assembled air barrier system to demonstrate that the building envelope is properly sealed and insulated. Passing the air barrier system leakage test and thermography test will result in system acceptance. Conform air barrier system leakage and thermography testing and reporting to the requirements of Section 07 05 23 PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS.

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 D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622	(2014) Apparent Density of Rigid Cellular Plastics
ASTM D1623	(2017) Standard Test Method for Tensile and Tensile Adhesion Properties 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 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

(2022) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

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 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

1.3 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, tested and/or produced to provide the primary resistance to airflow through an air barrier assembly of a wall system.

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 tested 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) as established by ASTM E2178.

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.

1.3.11 Vapor Permeance

Vapor permeance is separated into three classes based on the water vapor permeance of a material as tested via ASTM E96/E96M

Class I Vapor Barrier/Retarder 0.1 perm or less

Class II Vapor Barrier/Retarder 0.1 perm to 1.0 perm

Class III Vapor Barrier/Retarder 1.0 perm to 10 perm

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Air Barrier System Shop Drawings; G, Manufacturer produced warranted air barrier system

SD-03 Product Data

Air Barrier System Product Data; G

SD-04 Samples

Material Samples For Air Barrier System; G

SD-05 Design Data

Design Data And Calculations For The Air Barrier System; G, Manufacturer produced warranted air barrier system

SD-06 Test Reports

Design Review Report; G

Testing and Inspection; G

SD-07 Certificates

Air Barrier Inspector; G

1.6 AIR BARRIER ENVELOPE SURFACE AREA AND LEAKAGE REQUIREMENTS

The building air barrier systems must meet the following leakage requirements. The allowable leakage rate and the maximum leakage are at a differential test pressure of 75 Pa.

Air Barrier Envelope 1	
Surface Area	36,858 square feet
Architectural Only Test:	
Allowable leakage rate	0.25 CFM/sq.ft
Maximum leakage	9,215 total CFM

1.7 AIR BARRIER INSPECTOR

Employ a designated Air Barrier Inspector on this project. The Air Barrier Inspector performs a Design Review, 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 verifies that the constructed work is in accordance with both the manufacturer's recommendations for products used, the content of this specification and other contract drawings or documents. Qualification for the Air Barrier Inspector are as follows:

- a. Training and certification as an Air Barrier Auditor from the Air Barrier Association of America (ABAA) or other third party air barrier association.
- b. Or, provide documentation in resume format that demonstrates that the individual proposed has the experience, knowledge, skills and abilities to fulfill the above stated duties as the air barrier inspector.
- c. It is acceptable that this individual be employed by the firm who will be performing the building pressurization test or another independent third party entity, provided they meet the above requirements but is not a member of the installing contractor or firm.

Provide copies of Air Barrier Inspector qualifications 30 days after Notice to Proceed.

1.8 DESIGN REVIEW

Review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the construction of an effective air barrier system. Provide a [Design Review Report](#) individually listing each deficiency and the corresponding proposed corrective action necessary for proper air barrier system. Provide copies of the Design Review Report not later than 14 days after approval of the Air Barrier Inspector Qualifications. Submit [design data and calculations for the Air Barrier System](#) for a manufacturer produced warranted air barrier system.

PART 2 PRODUCTS

2.1 AIR BARRIER

Provide air barrier system of compatible parts from one or several manufacturers coordinated by the contractor or provide a single warranted system provided by a primary manufacturer. The air barrier system as part of a tested exterior wall assembly must meet the conditions of acceptance as tested in accordance with [NFPA 285](#). Materials used for roof assembly air barrier must conform to the appropriate UL and FM wind and fire

requirements for the specified roof assemblies.

If a complete air barrier system from a single manufacturer is utilized, whether warranted or not warranted, the air barrier system must conform to [ASTM E2357](#).

Materials in the following categories as used in the air barrier system or assembly of the exterior wall system are tested and are required to conform to [ASTM E2178](#): Self-adhered sheet membranes, fluid applied membranes, spray polyurethane foam, mechanically fastened commercial building wrap, factory bonded membranes to sheathing, and adhesive backed commercial building wrap and accessory products.

Other materials used as an air barrier such as concrete, glass, wood, metal or gypsum board may or may not conform to [ASTM E2178](#) but are acceptable provided that when integrated into the air barrier system or assemblies that they are not subject to material or environmental induced degradation in their final produced state and once incorporated in the permanent construction.

All materials used must be identifiable through manufacturer testing data and/or literature to be compatible with all the attached or adjoining materials or substrates used in the system.

Provide [Air Barrier System Shop Drawings](#), [Material Samples for Air Barrier System](#) and [Air Barrier System Product Data](#).

2.1.1.1 Spray Polyurethane Foam

Closed cell spray polyurethane foam for window and door frame voids is zero ozone depleting, HFC blown. Foam achieves a nominal in place core density of 1.9 to 2.4 PCF and has an aged R-value of 5.8 or more per inch for thicknesses of 2.5 inches or less at a 75 F mean temperature.

Type of Construction	Insulation Thickness	R-5.8 per Inch
Window, door and similar opening perimeters	Varies	Varies

Closed cell spray polyurethane is zero ozone depleting, HFC blown. The compound is a two part, medium density, MDI based, polyurethane thermoset rigid foam. Thermal resistance as measured in accordance with ASTM C 518 is an aged R-value of 5.8 or more per inch for thicknesses of 2.5 inches or less at a 75 degree F mean temperature. Thermal resistance as measured in accordance with ASTM C 518 is an aged R-value of 6.4 or more per inch for thicknesses greater than 2.5 inches at a 75 degree F mean temperature.

Closed Cell Insulation	Performance	Standard
Compressive strength	25 PSI	ASTM D1621
In place core density	1.9 to 2.4 PCF	ASTM D1622
Tensile strength	23 PSI	ASTM D1623
Water absorption, 75 F, 95% RH, 28 days	Less than 2%	ASTM D2126
Closed cell content	88 to 95%	ASTM D2842
Flame spread rating	Less than 25	ASTM E84
Smoke developed rating	More than 450	ASTM E84
Moisture vapor transmission	1.3 perm inches	ASTM E96/E96M
Air permeability	0.013	ASTM E283

Type of Construction	Insulation Thickness	R-6.4 per Inch
Wall to roof framing conditions	Varies	Varies

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 [Testing And 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). Perform adhesion tests as follows: Using a coring tool remove a sample and determine the relative adhesion quality of the foam. If the foam is hard to remove and leaves small bits of foam on the substrate it is called cohesive foam failure and is considered the best adhesion. If the foam comes away from the substrate with some force but is clean, it is called a mechanical bond. If it comes away easily from the substrate, the adhesion is poor. Cohesive foam failure and a good mechanical bond are acceptable.
- 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.

-- End of Section --

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

(2022) Standard Test Methods for Gravimetric Determination of Water 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, Section 07 05 23 PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS 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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications of Manufacturer; G

Qualifications of Installer; G

SD-02 Shop Drawings

Self-adhering Air Barrier; G

SD-03 Product Data

Self-adhering Air Barrier; G

Primers, Adhesives, and Mastics; G

Safety Data Sheets; G

SD-06 Test Reports

Field Peel Adhesion Test; G

Flame Propagation of Wall Assemblies; G

Flame Spread and Smoke Developed Index Ratings; G

Site Inspections and Testing; G

SD-07 Certificates

Self-adhering Air Barrier; G

SD-08 Manufacturer's Instructions

Self-adhering Air Barrier; G

Primers, Adhesives, and Mastics; G

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 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 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](#). 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 and Section [07 05 23](#) PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS.

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): In accordance with Section 07 27 10.00 10 BUILDING AIR BARRIER SYSTEM.
- b. Air Leakage (ASTM E2357, ASTM E283): In accordance with Section 07 27 10.00 10 BUILDING AIR BARRIER SYSTEM and Section 07 05 23 PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS.
- 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 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 gypsum sheathing an adequate number of coats to achieve required bond, with adequate drying time between coats.
- b. Prime wood, metal, and painted substrates with primer.
- c. 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,, Section 07 05 23 PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS, 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 07 27 26

FLUID-APPLIED MEMBRANE 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 C836/C836M

(2018; R 2022) Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use With Separate Wearing Course

ASTM D412

(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension

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 D5590

(2000; R 2010; E 2012) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay

ASTM E84

(2020) Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM E96/E96M

(2022) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

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, Section 07 05 23 PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS, 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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications of Manufacturer; G

SD-02 Shop Drawings

Fluid-Applied Membrane Air Barrier; G

SD-03 Product Data

Fluid-Applied Membrane Air Barrier; G

Transition Membrane; G

Primers, Adhesives, and Mastics; G

Reinforcement; G

Safety Data Sheets; G

SD-04 Samples

Fluid-Applied Membrane Air Barrier [Mockup](#); G

SD-06 Test Reports

Capillary Moisture Test; G

Field Peel Adhesion Test; G

Flame Propagation of Wall Assemblies; G

Flame Spread and Smoke Developed Index Ratings; G

Site Inspections Reports; G

SD-07 Certificates

Fluid-Applied Membrane Air Barrier; G

Transition Membrane; G

SD-08 Manufacturer's Instructions

Fluid-Applied Membrane Air Barrier; G

Transition Membrane; G

Primers, Adhesives, and Mastics; G

1.4 MISCELLANEOUS REQUIREMENTS

For [fluid-applied membrane air barriers](#) provide the following:

1.4.1 Shop Drawings

Submit fluid-applied membrane air barrier shop drawings showing locations and extent of barrier assemblies, transition membranes, details of all typical conditions, intersections with other envelope 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 fluid-applied membrane air barrier. 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 capillary moisture tests and [field peel adhesion tests](#) on all substrate 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 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.

1.6 CAPILLARY MOISTURE TEST

Perform a [capillary moisture test](#) by plastic sheet method in accordance with [ASTM D4263](#) on the construction mockup and substrate materials. Perform test after curing period as recommended by the air barrier manufacturer. Record mode of failure and area which failed in accordance with [ASTM D4263](#). Once the air barrier material manufacturer has established a minimum adhesion or moisture level for the product on the particular substrate, indicate on the inspection report whether this requirement has been met. Where the manufacturer has not declared a minimum adhesion or moisture value for their product and substrate combination, the inspector must record actual values.

1.7 FIELD PEEL ADHESION TEST

Perform a field peel adhesion test on a construction mockup. Test the applied product for adhesion in accordance with manufacturer's recommendations. Perform test after curing period recommended by the manufacturer. Record mode of failure and area which failed in accordance with [ASTM D4541](#). When the manufacturer has established a minimum adhesion level for the product on the particular substrate, the inspection report must indicate whether this requirement has been met. Where the manufacturer has not declared a minimum adhesion value for their product/substrate combination, the inspector must record actual values.

1.8 AIR BARRIER TESTING

Perform air barrier testing in accordance with Section 07 27 10.00 10 BUILDING AIR BARRIER SYSTEM and Section 07 05 23 PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS.

1.9 QUALITY ASSURANCE

1.9.1 Qualifications of Manufacturer

Submit documentation verifying that manufacturer of fluid-applied membrane air barrier is currently accredited by the Air Barrier Association of America (ABAA Accreditation <https://www.airbarrier.org/>).

1.10 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 construction mock up, 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 fluid-applied membrane air barrier.

1.11 ENVIRONMENTAL CONDITIONS

1.11.1 Temperature

Install fluid-applied membrane air barrier within the range of ambient and substrate temperatures as recommended in writing by the fluid-applied membrane air barrier manufacturer. Do not apply fluid-applied membrane air barrier to a damp or wet substrate. 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.

1.11.2 Exposure to Weather

Protect fluid-applied membrane 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 FLUID-APPLIED MEMBRANE AIR BARRIER

Provide a fluid-applied, vapor retarding, air barrier. This barrier must exhibit no visible water leakage when tested in accordance with ASTM E331 and must perform as a liquid water drainage plane with thru-wall flashing to discharge incidental condensation and water penetration to the exterior of the building enclosure. Provide products suitable for use within temperature ranges specified by manufacturer for the location of the project.

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 0.04 CFM per sf at 1.57 psf at one inch.
- a. Water Vapor Permeance (Vapor Impermeable Membrane) (ASTM E96/E96M, desiccant method A): 0.1 perms or less.
- b. Tensile Strength (ASTM D412): Not less than 138 psi.
- c. Elongation (ASTM D412): Not less than 300 percent.
- d. Low temperature Flexibility and Crack Bridging (ASTM C836/C836M): Pass at minus 15 degrees F.
- e. Solids by Volume: minimum 50 percent.
- f. Flame propagation of wall assemblies (NFPA 285): Pass
- g. Surface Burning Characteristics (ASTM E84):
 - (1) Flame Spread Index Rating not higher than 75.
 - (2) Smoke Developed Index Rating not higher than 150.
- h. Resistance to Mold, Mildew and Fungal Growth (ASTM D5590): 0, No growth.

2.2 PRIMERS, ADHESIVES, AND MASTICS

Provide primers, adhesives, mastics, sealants and other accessories as recommended by manufacturer of fluid-applied membrane air barrier for a complete installation.

2.3 TRANSITION MEMBRANE

Provide as specified in Section 07 27 19.01 SELF-ADHERING AIR BARRIERS.

2.4 SHEET METAL FLASHING

Provide as specified in Section 07 60 00 FLASHING AND SHEET METAL.

2.5 JOINT SEALANTS

Provide as specified in Section 07 92 00 JOINT SEALANTS.

2.6 REINFORCEMENT

Provide fiberglass mesh tape, or fluid-applied air barrier manufacturer's approved comparable equal product, reinforcement at seams, edges, projections and penetrations. Reinforce all joints exceeding 1/4 inch with fiberglass mesh.

PART 3 EXECUTION

3.1 EXAMINATION

Before installing fluid-applied membrane air barrier, examine substrates, areas, and conditions under which fluid-applied membrane 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 detrimental to the adhesion of the membranes.
- b. Masonry surfaces are cured and dry, smooth without large voids, spalled areas or sharp protrusions. Do not proceed with installation until after minimum concrete curing period recommended by fluid-applied membrane air barrier manufacturer.
- c. Fill voids, gaps and spalled areas in substrate to provide an even plane. Strike masonry joints full flush.
- d. 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.
- e. Verify sealants used in substrates, and in joints between substrates, are compatible with fluid-applied membrane air barrier.

3.2 PREPARATION

Clean, prepare, and treat substrate in accordance with manufacturer's written instructions. Ensure clean, dust-free, and dry substrate for fluid-applied membrane air barrier application.

- a. Remove dust, dirt and other contaminants from joints and cracks before coating surfaces.
- b. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through fluid-applied membrane air barrier.
- c. At changes in substrate plane, provide transition material (bead of sealant, mastic, extruded silicone sealant, membrane counterflashing or other material recommended by manufacturer) under transition membrane to eliminate all sharp 90 degree inside corners and to make a smooth transition from one plane to another.
- d. 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.
- e. For concrete and masonry substrates, fill all voids and holes, particularly in mortar joints, with non-shrinking grout.
- f. Mask off and cover adjacent surfaces to protect from spillage and overspray.

3.3 INSTALLATION

3.3.1 Installation of Transition Membrane

Install transition membrane materials in accordance with the details on the drawings, Section 07 27 19.01 SELF-ADHERING AIR BARRIERS, and the following:

- a. Install transition membrane at all required locations prior to installation of the fluid-applied membrane air barrier.
- b. Verify transition membrane is fully adhered to substrate and that its surface is clean, dry and wrinkle free prior to installation of the fluid-applied membrane air barrier.
- c. Verify transition membrane completely covers all transition areas and will provide continuity of the finished fluid-applied membrane air barrier without gaps or cracks.

3.3.2 Installation of Flashing

Counterflash upper edge of thru-wall flashing and fluid-applied air barrier. Counter flashing and thru-wall flashing are specified in Section 07 60 00 FLASHING AND SHEET METAL.

3.3.3 Installation of Fluid-Applied Membrane Air Barrier

Install materials in accordance with manufacturer's recommendations and the following:

- a. Apply fluid-applied membrane air barrier in single or dual coat application by spray or roller. Apply fluid-applied membrane air barrier within manufacturer's recommended temperature range for application.
- b. Apply fluid-applied membrane air barrier in manner and at rate and wet film thickness recommended by manufacturer to yield a finished dry film thickness of not less than 45 mils or as otherwise required by the manufacturer for the application substrate material and surface roughness..
- c. Apply fluid-applied membrane air barrier around all penetrations ensuring a complete and continuous air barrier. Lap fluid-applied membrane air barrier a minimum of 3 inch over transition membrane to seal leading edge.
- d. Seal membrane terminations, heads of mechanical fasteners, masonry tie fasteners, around penetrations, HVAC assemblies, plumbing and electrical assemblies, doors, windows, louvers, and other assemblies penetrating the fluid-applied membrane air barrier with a termination sealant recommended by the fluid-applied membrane air barrier manufacturer.
- e. Notify the Contracting Officer and Testing Agency upon completion of fluid-applied membrane air barrier installation. Air barrier materials and assemblies must remain exposed until tested and inspected by the ABAA.
- f. Do not allow materials to come in contact with chemically incompatible

materials.

3.3.4 Installation of Reinforcement

Install reinforcement at projections, corners, joints, and penetrations where applicable.

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, Section 07 05 23 PRESSURE TESTING AN AIR BARRIER SYSTEM FOR AIR TIGHTNESS, and this section.

- a. Conduct inspections and testing at 5, 50, and 95 percent completion of this scope of work. Forward written inspection reports to the Contracting Officer within five working days of the inspection and test being performed.
- b. If the inspections reveal any defects, promptly remove and replace defective work at no additional expense to the Government.

3.5 PROTECTION AND CLEANING

3.5.1 Protection

Protect fluid-applied membrane air barrier assemblies from damage during application and remainder of construction in accordance with manufacturer's written instructions.

Coordinate installation, testing, and inspection procedures to ensure exposure period does not exceed that recommended by the product manufacturer. Remove and replace, at no additional cost to the government, membrane products that exceed manufacturer's allowed exposure limits.

3.5.2 Cleaning of Adjacent Surfaces

Clean excess product from adjacent construction using cleaning agents and procedures as recommended in writing by the manufacturer of each type of affected construction and as acceptable to same.

3.6 CLEANUP OF SPILLS

Conduct cleanup of uncured product spillage in accordance with manufacturer's written safe handling instructions.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 07 60 00

FLASHING AND SHEET METAL
05/17, CHG 2: 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 ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 2605 (2020) Voluntary Specification,
Performance Requirements and Test
Procedures for Superior Performing Organic
Coatings on Aluminum Extrusions and Panels

ASTM INTERNATIONAL (ASTM)

ASTM A480/A480M (2020a) Standard Specification for General
Requirements for Flat-Rolled Stainless and
Heat-Resisting Steel Plate, Sheet, and
Strip

ASTM B32 (2020) Standard Specification for Solder
Metal

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 B370 (2022) Standard Specification for Copper
Sheet and Strip for Building Construction

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

1.2 GENERAL REQUIREMENTS

Finished sheet metal assemblies must form a weathertight enclosure without waves, warps, buckles, fastening stresses or distortion, while allowing for expansion and contraction without damage to the system. The sheet metal installer is responsible for cutting, fitting, drilling, and other operations in connection with sheet metal modifications 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, uninterrupted roofing operations.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Exposed Sheet Metal Coverings; G

Gutters; G

Downspouts; G

Drip Edges; G

Open Valley Flashing; G

Eave Flashing; G

Recycled Content; S

SD-04 Samples

Finish Samples; G

SD-08 Manufacturer's Instructions

Instructions for Installation; G

Quality Control Plan; G

SD-10 Operation and Maintenance Data

Cleaning and Maintenance; G

1.4 MISCELLANEOUS REQUIREMENTS

1.4.1 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.

1.4.2 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.

1.4.3 Operation and Maintenance Data

Submit detailed instructions for installation and quality control during installation, cleaning and maintenance, for each type of assembly

indicated.

1.5 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 installation.

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

Do not use lead, lead-coated metal, or galvanized steel. Use any metal listed by [SMACNA 1793](#) for a particular item, unless otherwise indicated. Provide materials, thicknesses, and configurations in accordance with [SMACNA 1793](#) for each material. Different items need not be of the same metal, except that if copper is selected for any exposed item, all exposed items must be copper, and that 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:

2.2.1 Exposed Sheet Metal Items

Must be of the same material. Consider the following as exposed sheet metal: gutters, including hangers; downspouts; cap, steeped, base, and eave flashings and related accessories.

2.2.2 Drainage

Do not use copper for an exposed item if drainage from that item will pass over exposed masonry, stonework or other metal surfaces.

2.2.3 Copper, Sheet and Strip

Provide in accordance with [ASTM B370](#), cold-rolled temper, H 00 (standard).

2.2.4 Stainless Steel

Provide in accordance with [ASTM A480/A480M](#), Type 302 or 304, 2D Finish, fully annealed, dead-soft temper.

2.2.5 Aluminum Alloy Sheet and Plate

Provide in accordance with **ASTM B209** form alloy, and temper appropriate for use. Provide material not less than **0.040-in** in thickness.

Furnish aluminum with an organic coating treatment conforming to AAMA 2605 to obtain a 70% PVDF coating.

2.2.5.1 Alclad

When fabricated of aluminum, fabricate the following items with Alclad 3003, Alclad 3004, or Alclad 3005, clad on one side unless otherwise indicated.

- a. Gutters, downspouts, and hangers
- b. Gravel stops and fascia
- c. Flashing

2.2.6 Finishes

Provide exposed exterior sheet metal and aluminum with a baked on, factory applied color coating of polyvinylidene fluoride (PVF2) or approved equal fluorocarbon coating. Dry film thickness of coatings must be **0.8 to 1.3 mils**. Color is slate gray as defined in the Marine Corps Base Camp Lejeune Base Exterior Architectural Plan, Rifle Range Historic Area and matching the metal roofing selection. Field applications of color coatings are prohibited and will be rejected.

2.2.7 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

ASTM B221.

2.2.8 Solder

Provide in accordance with **ASTM B32**, 95-5 tin-antimony.

2.2.9 Downspout Terminations

Downspout terminations are cast iron boots that receive cross sections encountered. Castings transition to round outlets of diameters indicated for connection to horizontal pipe systems. Furnish 90 degree, straight, offset or angular shoe transitions. Boots have a minimum of four pre punched or lug fastening flanges for wall substrate anchoring. Secure with 0.625 inch stainless steel bolts, washers and metal tube spacers matching downspout bracket internal stand offs. Typical installations require boots 3 feet, 0 inches in length and have approximately 1 foot, 8 inches exposed above grade. Provide extensions to accommodate greater exposed lengths. Factory prime iron castings for field finishing.

2.2.10 Bituminous Plastic Cement

Provide in accordance with **ASTM D4586/D4586M**, Type I.

2.2.11 Fasteners

Use stainless steel fasteners to fasten. Confirm compatibility of

fasteners and items to be fastened to avoid galvanic corrosion due to dissimilar materials.

Finish exposed rivets and fasteners to match substrate colors encountered.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Metal Fascias

3.1.2 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 required to accommodate terminations and edges and wherever indicated and necessary to make the work watertight. Join sheet metal items together as shown in Table II.

3.1.3 Nailing

Confine nailing of sheet metal generally to sheet metal having a maximum width of 18 inches. 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. Secure flashing at one-half the normal interval to ensure a wind-resistant installation.

3.1.4 Cleats

Provide cleats for sheet metal 18 inches and over in width. Cleats are continuous. Unless otherwise specified, provide cleats of 2 inches wide 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. Pre-tin cleats for soldered seams.

3.1.5 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 inches or less in thickness.

3.1.6 Seams

Straight and uniform in width and height with no solder showing on the face.

3.1.6.1 Flat-lock Seams

Finish not less than $3/4$ inch wide.

3.1.6.2 Lap Seams

Finish soldered seams not less than one inch wide. Overlap seams not soldered, not less than 3 inches.

3.1.6.3 Loose-Lock Expansion Seams

Not less than 3 inches 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.

3.1.6.4 Standing Seams

Not less than one inch high, double locked without solder.

3.1.6.5 Flat Seams

Make seams in the direction of the flow.

3.1.7 Soldering

Where soldering is specified, apply to copper and stainless steel items. Pre-tin edges of sheet metal before soldering is begun. Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

3.1.8 Mechanical Fastening

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.

3.1.8.1 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 inches maximum on center. Where end lap fasteners are required to improve closure, locate the end lap fasteners not more than 2 inches from the end of the overlapping sheet.

3.1.9 Protection from Contact with Dissimilar Materials

3.1.9.1 Copper or Copper-bearing Alloys

Paint with heavy-bodied bituminous paint surfaces in contact with dissimilar metal, or separate the surfaces by means of moistureproof building felts.

3.1.9.2 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.

3.1.9.3 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.10 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 fascia by expansion and contraction joints spaced not more than 12 feet apart.

3.1.11 Counterflashing

Except where indicated or specified otherwise, insert counterflashing in reglets located from 9 to 10 inches above roof decks, extend down vertical surfaces over upturned vertical leg of base flashings not less than 3 inches. Fold the exposed edges of counterflashings 1/2 inch. Where stepped counterflashings are required, they may be installed in short lengths a minimum 8 inches by 8 inches or may be of the preformed single piece type. Provide end laps in counterflashings not less than 3 inches and make it weathertight with plastic cement. Do not make lengths of metal counterflashings exceed 10 feet. Form flashings to the required shapes before installation. Factory form corners not less than 12 inches from the angle. Secure the flashings in the reglets with lead wedges and space not more than 18 inches 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 inches into the walls. Install counterflashing to provide a spring action against base flashing.

3.1.12 Metal Reglets

Keep temporary cores in place during installation. Ensure factory fabricated caulked type or friction type, reglets have a minimum opening of 1/4 inch and a minimum depth of 1-1/4 inch, when installed.

3.1.12.1 Caulked Reglets

Wedge flashing in reglets with lead wedges every 18 inches, caulked full and solid with an approved compound.

3.1.12.2 Friction Reglets

Install flashing snap lock receivers at 24 inches on center maximum. When flashing has been inserted the full depth of the slot, caulk the slot, lock with wedges, and fill with sealant.

3.1.13 Metal Drip Edges

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 inches and secure with compatible nails spaced not more than 10 inches on center along upper edge.

3.1.14 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 inches 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. Support gutters on by continuous cleats. Adjust gutters to slope uniformly to outlets, with high points occurring midway between outlets. Fabricate hangers and fastenings from compatible metals.

3.1.15 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 an intermediate point 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.

3.1.15.1 Terminations

Neatly fit into the downspout boots terminating in drainage lines and seal the joints.

Locate cast iron downspout boot bolts in masonry joints. Provide pipe fittings to accommodate shoe transitions. Align tops at a consistent elevation.

3.1.16 Open Valley Flashing

Provide valley flashing free of longitudinal seams, of width sufficient to extend not less than 6 inches under the roof covering on each side. Provide a 1/2 inch fold on each side of the valley flashing. Lap the sheets not less than 6 inches in the direction of flow and secure to roofing construction with cleats attached to the fold on each side. Nail the tops of sheets to roof sheathing. Space the cleats not more than 12 inches on center. Provide exposed flashing not less than 4 inches in width at the top and increase one inch in width for each additional 8 feet in length. Where the slope of the valley is 4.5 inches or less per foot, or the intersecting roofs are on different slopes, provide an inverted V-joint, one inch high, along the centerline of the valley; and extend the

edge of the valley sheets 8 inches under the roof covering on each side.

3.1.17 Eave Flashing

One piece in width, applied in 8 to 10 foot lengths with expansion joints spaced as specified in paragraph EXPANSION AND CONTRACTION. Provide a 3/4 inch continuous fold in the upper edge of the sheet to engage cleats spaced not more than 10 inches on center. Locate the upper edge of flashing not less than 18 inches from the outside face of the building, measured along the roof slope. Fold lower edge of the flashing over and loose-lock into a continuous edge strip on the fascia. Where eave flashing intersects metal valley flashing, secure with one inch flat locked joints with cleats that are 10 inches on center.

3.1.18 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 inches. 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.

3.1.19 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. Goose-necks, rain hoods, power roof ventilators, and similar items are specified in other sections.

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.

3.3 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	Copper kilograms per square foot	Aluminum, inch	Stainless Steel, inch		
Downspouts and leaders	16	.032	.015		
Downspout clips and anchors	-	.040 clip .125 anchor	-		
Downspout straps, 2-inch	48 (a)	.060	.050		

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES					
Sheet Metal Items	Copper kilograms per square foot	Aluminum, inch	Stainless Steel, inch		
Strainers, wire diameter or gage	No. 9 gage	.144 diameter	.109 diameter		
Flashings:					
Base	20	.040	.018		
Eave	16	-	.015		
		-			
		-			
Pipe vent sleeve					
Extrusions	-	.075	-		
Sheets, smooth	20	.050	.018		
Edge strip	24	.050	.025		
Gutters:					
Gutter section	16	.032	.015		
Continuous cleat	16	.032	.015		
Hangers, dimensions	1 inch by 1/8 inch (a)	1 inch by . inch	1 inch by .0 inch		

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES					
Sheet Metal Items	Copper kilograms per square foot	Aluminum, inch	Stainless Steel, inch		
		-			
(a) Brass.					

TABLE II. SHEET METAL JOINTS			
TYPE OF JOINT			
Item Designation	Copper and Stainless Steel	Aluminum	Remarks
Flashings			

TABLE II. SHEET METAL JOINTS			
TYPE OF JOINT			
Item Designation	Copperl and Stainless Steel	Aluminum	Remarks
Base	One inch 3 inch lap for expansion joint	One inch flat locked, soldered; sealed; 3 inch lap for expansion joint	Aluminum manufacturer's recommended hard setting sealant for locked aluminum joints. Fill each metal expansion joint with a 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.
			--
Edge strip	Butt	Butt	--
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.

TABLE II. SHEET METAL JOINTS			
TYPE OF JOINT			
Item Designation	Copperl and Stainless Steel	Aluminum	Remarks
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.

-- End of Section --

SECTION 07 61 15.00 20

ALUMINUM STANDING SEAM ROOFING
08/16, CHG 2: 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.

ALUMINUM ASSOCIATION (AA)

AA ADM (2020) Aluminum Design Manual

AA ASM-35 (2000) Specifications for Aluminum Sheet Metal Work in Building Construction, Construction Manual Series Section 5

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 2605 (2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3 (2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN WOOD COUNCIL (AWC)

AWC NDS (2015) National Design Specification (NDS) for Wood Construction

ASTM INTERNATIONAL (ASTM)

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 D522/D522M (2017) Mandrel Bend Test of Attached Organic Coatings

ASTM D523 (2014; R 2018) Standard Test Method for Specular Gloss

ASTM D714 (2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints

ASTM D968 (2017) Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive

ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D2247	(2015) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D2565	(2016) Standard Practice for Xenon Arc Exposure of Plastics Intended for Outdoor Applications
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
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
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
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

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA CONDET	(2014) Construction Details Manual
-------------	------------------------------------

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition
-------------	--

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)
-------------	---

1.2 DEFINITIONS

1.2.1 Field-Formed Seam

Seams of panels so configured that when adjacent sheets are installed the seam is sealed utilizing mechanical or hand seamers. Crimped (45 degree bend), roll formed (180 degree bend), double roll formed (2 - 180 degree bend), and roll and lock systems are types of field-formed seam systems.

1.2.2 Snap Together Seam

Panels so configured that the male and female portions of the seam interlock through the application of foot pressure or tamping with a mallet. Snap-on cap configurations are a type of snap together system.

1.2.3 Pre-Formed

Formed to the final, less field-formed seam, profile and configuration in the factory.

1.2.4 Field-Formed

Formed to the final, less field-formed seam, profile and configuration at the site of work prior to installation.

1.2.5 Roofing System

The roofing system is defined as the assembly of roofing components, including roofing panels, flashing, fasteners, and accessories which, when assembled properly result in a watertight installation.

1.2.6 SSMRS

Standing Seam Metal Roof System (SSMRS) is abbreviation of the entire roof system specified herein with all components and parts coming from a single manufacturer's system.

1.3 SYSTEM DESCRIPTION

1.3.1 Design Requirements

- a. Provide continuous length panels with no joints or seams, except where indicated. Individual panels must be removable for replacement of damaged material.
- b. There must be no exposed or penetrating fasteners except where shown on the approved shop drawings. Fasteners into wood must be stainless steel sheet metal screws with full length threads. Fasteners into steel must be stainless steel or cadmium plated stainless steel screws inserted into predrilled holes. Length and diameter of screws must be sufficient to meet the design loads with a suitable factor of safety for the material to which the roofing components are attached. Calculate fastener capacity in accordance with [AISI S309-3](#), [AA ADM](#) or [AWC NDS](#) as applicable.
- c. Roof panel standing seam must include a capillary break and be mechanically locked closed by the manufacturer's locking tool. The seam must include a continuous sealant when required by the manufacturer to withstand the rainfall and wind specified in paragraph

MANUFACTURER'S REQUIREMENTS.

- d. Roof panel anchor clips must be concealed and designed to allow for thermal movement of the panels, except where specific fixed points are indicated.
- e. The system must resist the positive and negative loads specified herein in accordance with "Sheet Building Sheathing Design Guide" of the AA ADM. Determine capacity in accordance with principles of ASTM E330/E330M modified as follows:
 - (1) Test panels must be production material of the type proposed for use. Use either full length or partial length panels with attachment representative of the main part of the roof.
 - (2) Test specimens must be five panels wide, span one or more supports, and must have no end or edge attachment or seals that will restrict crosswise movement of the panels under load. Do not bridge longitudinal seams with tape or film that can restrict separation.
 - (3) Test panels to failure. Report load at failure.
- f. Panels must support walking loads without excessive distortion or telegraphing of the structural supports. Panels must support a 250 pound load concentrated on a 4 square inch area at the center of the panel without buckling or permanent distortion.
- g. Submit a DELEGATED DESIGN with sealed calculations and shop drawings prepared by a registered professional engineer.

Furnish prefabricated, double lock roofing systems that resist uplift and lateral loads. Apply appropriate ASCE 7 parameters. Marine Corps Base Camp Lejeune must resist a 145 mile per hour wind load. Assembly design responsibility is delegated to the Contractor and incorporates specific properties and structural capabilities of selected products and manufacturers.

Supplement delegated design shop drawings with roofing system structural computations. Tie general manufacturer data of appurtenant members utilized to project specific conditions. Specify fastening patterns and connections.

Specified panel gauges are minimums. Provide greater panel thicknesses as dictated by a delegated design that accounts for the available purlin spacing using recommended cleat, bearing plate and fastener pattern combinations. Provide additional structural members to reduce panel spans and accommodate the quantity of cleat, bearing plate and fastener pattern combinations to resist specified loads.

1.3.2 Performance Requirements

1.3.2.1 Wind Loads

Resistance to wind uplift generated by winds of 145 mph. Divide roofs supported by solid decking into field, edge and corner pressure zones. Stipulate requirements for additional fasteners. Comply with the pressurization standards of UL 580, Class 90 and FMRC 4470, Class 1-90.

1.3.2.2 Resistance to Water Infiltration

Roofing system must show no infiltration at seams, edges, flashings, counterflashings and penetrations when subjected to a rainfall of 5 inches per hour with 124 mph wind.

1.3.2.3 Thermal Movement

The system must be capable of withstanding thermal movement based on a temperature range of 10 degrees F below design low air temperature and 140 degrees F for mill finish and light colors and 180 degrees F for dark colors.

1.3.2.4 Deflection

Panel deflection must not exceed L/140.

1.3.2.5 Structural Performance

The structural performance test methods and requirements must be in accordance with ASTM E1592.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roofing Panels; G

Submit drawings as necessary to supplement the instructions and diagrams. Include design and erection drawings containing an isometric view of the roof showing the design uplift pressures and dimensions of edge, ridge and corner zones. Show typical and special conditions including flashings, accessory installation, materials and thicknesses, all dimensions, anchoring methods, sealant locations, sealant tape locations, fastener layout, sizes, spacing, provisions for thermal movement, terminations, penetrations, and attachments. Details of installation must be in accordance with the manufacturer's Standard Instructions and details or the SMACNA 1793. The manufacturer's technical engineering department must approve the drawings before they are submitted.

SD-03 Product Data

Roofing Panels; G

Energy Star Label for Aluminum Roofing Product; S

Recycled Content of Aluminum Roofing Products; S

Closures

Accessories

Sample Warranty Certificate; G

Submit for all materials to be provided. Submit data sufficient to indicate conformance to specified requirements.

SD-04 Samples

Roofing Panels

Submit a 12 inch long section of typical panel in color selected.

For color selection, submit 2 by 4 inch metal samples in color, finish and texture selected from a palette of twenty standard selections.

Accessories

Submit each type of accessory item used in the project including, but not limited to: each type of anchor clip, closures, fasteners and leg clamps.

SD-05 Design Data

Load Calculations; G

SD-06 Test Reports

Structural Performance; G

Panel Finish; G

Submit reports of the tests required by this section.

Manufacturer's Field Inspection; G

Submit manufacturer's technical representative's inspection reports as required in paragraph MANUFACTURER'S FIELD INSPECTION.

SD-07 Certificates

Technical Representative

Qualification of Installer

Submit documentation proving the installer is factory-trained, has the specified experience and is authorized by the manufacturer to install the products specified.

Coil Stock Compatibility; G

Provide certification of coil compatibility with roll forming machinery to be used for forming panels without warping, waviness, and rippling not part of panel profile; to be done without damage, abrasion or marking of finish coating.

SD-08 Manufacturer's Instructions

Sealant

Submit manufacturer's sealant requirements for roofing.

Installation Manual; G

Submit manufacturer's printed installation manual/instructions and standard details.

SD-11 Closeout Submittals

Information Card

For each roofing installation, submit a typewritten card or photoengraved aluminum card containing the information listed on Form 1 located at the end of this section.

Warranty

1.5 LOAD CALCULATIONS

Submit load calculations for the following by a structural engineer registered as a Professional Engineer in any jurisdiction verifying that the system supplied meets the design loads indicated. Coordinate calculations with manufacturer's test results.

- a. Wind load uplift design pressure at roof locations specified in paragraph WIND LOADS.
- b. Clip spacing and allowable load per clip calculations.
- c. The fastening of clips to structure or intermediate support spacing.
- d. Intermediate support spacing and fastening to structure when required.
- e. Allowable panel span at anchorage spacing indicated.
- f. Safety factor used in determining loading.

1.6 QUALITY ASSURANCE

1.6.1 Preroofing Conference

After submittals are received and approved but before roofing and insulation work, including associated work, is preformed, the Contractor must hold a preroofing conference to review the following:

- a. The drawings and specifications
- b. Procedure for on site inspection and acceptance of the roofing substrate and pertinent structural details relating to the roofing system
- c. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing
- d. Safety requirements.

The prerooting conference must be attended by the Contractor and personnel directly responsible for the roofing and insulation installation, mechanical and electrical work, and the roofing manufacturer's technical representative. Conflicts among those attending the prerooting conference must be resolved and confirmed in writing before roofing work, including associated work, is begun. Prepare written minutes of the prerooting conference and submit to the Contracting Officer.

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 and with installations in the geographical area where construction will take place. The manufacturer's representative must be an employee of the manufacturer with at least 5 years experience in installing the roof system. The representative must be available to perform field inspections and attend meetings as required herein, and as requested by the Contracting Officer.

1.6.3 Qualification of Installer

The roofing system installer must be factory-trained, approved by the aluminum roofing system manufacturer to install the system, and must have a minimum of three years experience as an approved applicator with that manufacturer. The applicator must have applied five installations of similar size and scope to this project within the previous 3 years.

1.6.4 Single Source

Provide roofing panels, clips, closures and other accessories from a single manufacturer.

1.6.5 Manufacturer

The SSMRS must be the product of an aluminum roofing industry recognized SSMRS manufacturer who has been in the practice of manufacturing SSMRS for a period of not less than 5 years and who has been involved in at least 5 projects similar in size and complexity to this project.

1.6.6 Laboratory Tests For Panel Finish

Previously manufactured panels of the same type and finish as proposed for the project must have been tested by an approved testing laboratory to ensure conformance to specifications. The term "appearance of base metal" refers to the aluminum base metal. Panels must meet the following test requirements.

1.6.6.1 Salt Spray Test

Panels must withstand a salt spray test for a minimum of 2000 hours in accordance with ASTM B117, including the scribe requirement in the test. Immediately upon removal of the panel from the test, coating must receive a rating of 10, no blistering, as determined by ASTM D714; and a rating of 7, 1/16 inch failure at scribe, as determined by ASTM D1654, Rating Schedule No. 1.

1.6.6.2 Formability Test

For formability test, when subjected to a 180 degree bend over a 1/8 inch

diameter mandrel in accordance with [ASTM D522/D522M](#), exterior coating film must show only microchecking of the exterior film and there must be no loss of adhesion.

1.6.6.3 Accelerated Weathering Test

Panels must withstand an accelerated weathering test for a minimum of 2000 hours in accordance with [ASTM G152](#), [ASTM G153](#) or [ASTM D2565](#) without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with a penknife blade or similar instrument will be considered to indicate loss of adhesion.

1.6.6.4 Chalking Resistance

After the 2000-hour weatherometer test, exterior coating may not chalk greater than No. 8 rating when measured in accordance with [ASTM D4214](#) test procedures.

1.6.6.5 Abrasion Resistance Test for Color Coating

When subjected to the falling sand test in accordance with [ASTM D968](#), coating system must withstand a minimum of 100 liters of sand per 0.025 mm (mil) of coating thickness before appearance of base metal.

1.6.6.6 Humidity Test

When subjected to a humidity cabinet test in accordance with [ASTM D2247](#) for 1000 hours, a scored panel must show no signs of blistering, cracking, creepage, or corrosion.

1.6.6.7 Fire Hazard

The finish on factory-fabricated panels must have a flame spread rating of not more than 75 when tested in accordance with [ASTM E84](#).

1.6.6.8 Gloss

The gloss of the finish must be 30 plus or minus 5 at an angle of 60 degrees, when measured in accordance with [ASTM D523](#).

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle preformed panels, bulk roofing products and other manufactured items in a manner to prevent damage or deformation.

1.7.1 Delivery

Provide adequate packaging to protect materials during shipment. Do not uncrate materials until ready for use except for inspection. Immediately upon arrival of materials at jobsite, inspect materials for damage, dampness, and staining. Replace damaged or permanently stained materials that cannot be restored to like-new condition with new material. If materials are wet, remove moisture, restack and protect panels until used.

1.7.2 Handling

Handle material carefully to avoid damage to surfaces, edges and ends.

1.7.3 Storage

Stack materials stored on the site on platforms or pallets and cover with tarpaulins or other suitable weathertight coverings which prevent water trapping or condensation. Store panels so that water which might have accumulated during transit or storage will drain off. Do not store the panels in contact with materials that might cause staining, such as mud, lime, cement, fresh concrete or chemicals. Protect stored panels from wind damage.

1.8 WARRANTY

Furnish manufacturer's no dollar limit materials and workmanship warranty for the roofing system. The warranty period must be not less than 20 years from the date of Government acceptance of the work. Issue the warranty directly to the Government. The warranty must provide that if within the warranty period the aluminum roofing system becomes non-watertight or shows evidence of corrosion, perforation, peeling paint, rupture or excess weathering due to deterioration of the roofing system resulting from defective materials or workmanship the repair or replacement of the defective materials and correction of the defective workmanship must be the responsibility of the roofing system manufacturer. Repairs that become necessary because of defective materials and workmanship while roofing is under warranty must be performed within 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time will constitute grounds for having the repairs performed by others and the cost billed to the manufacturer. In addition, provide a 2 year contractor installation warranty.

PART 2 PRODUCTS

2.1 ROOFING PANELS

2.1.1 Material

3004 aluminum, [ASTM B209](#). Aluminum roofing materials must contain a minimum of 30 percent total recycled content. Provide data identifying percentage of [recycled content of aluminum roofing products](#).

Provide aluminum roofing product that is [Energy Star](#) labeled. Provide data identifying [Energy Star label for aluminum roofing product](#). Provide solar reflectance product with an initial solar reflectance greater than or equal to 0.25 and a solar reflectance greater than or equal to 0.15 three years after installation under normal conditions.

2.1.1.1 Thickness

[0.040 inch](#) minimum.

2.1.1.2 Finish

Give aluminum sheet coil for heavy commercial applications a pretreatment to enhance adhesion followed by a caustic etch or alkaline wash for cleaning and degreasing. Apply a phosphate spray or chromate conversion treatment to protect against humidity and corrosive chemicals. Furnish an organic coating treatment conforming to AAMA 2605 to obtain a 70% PVDF coating. Provide a two coat application consisting of 0.2 mils of primer with a 0.7 mil topcoat that achieves a 0.9 mil thickness.

2.1.1.3 Texture

Smooth..

2.1.1.4 Color

Exterior color is sandstone as defined in the Marine Corps Base Camp Lejeune Base Exterior Architectural Plan, Rifle Range Historic Area.

2.1.1.5 Configuration

Provide panels of continuous lengths from ridge to eaves or from top to eaves on shed roof designs. Panels must be 12 inches wide with a minimum 2.0 inch high vertical legs and two 0.37 inch stiffening ribs at 4 inches on center between the legs to minimize oil-canning and telegraphing of structural members. Leading vertical leg must have a continuous groove in the rib top for anti-siphon protection when hook-rib top of next panel is locked over leading vertical leg to form the standing seam. Panels from coil stock must be formed without warping, waviness or ripples not a part of the panel profile, and must be free of damage to the finish coating system.

2.1.1.6 Prefinished Coating System

Fluorocarbon baked enamel, factory-applied, minimum total dry film nominal thickness of 0.7 mils, and conforming to test requirements specified herein. Provide prefinished coating system on the exterior face. Interior face must receive same coating system, or, at the manufacturer's option, receive a coat of acrylic wash coat applied to a minimum total dry film nominal thickness of 0.20 mil.

2.2 ACCESSORIES

Sheet metal flashings, trim, moldings, closure strips, caps, preformed crickets, equipment curbs, and other similar sheet aluminum accessories provided in conjunction with preformed aluminum panels must be of the same material and finish as panels, except that such items which will be concealed after installation may be provided without the finish if they are aluminum or stainless steel. Provide ridge and rib closures, as specified. Aluminum must be of thickness not less than that of panels. Molded closure strips must be closed-cell synthetic rubber, neoprene, or polyvinyl chloride premolded to match configurations of preformed aluminum panels. Thermal spacer blocks and other thermal barriers at concealed fasteners must be as recommended by the roofing panel manufacturer.

2.2.1 Closures

2.2.1.1 Ridge Closure

Aluminum-clad foam or aluminum closure with foam secondary closure matching panel configuration for installation on surface of roof panel between panel ribs at ridge and headwall roof panel flashing conditions and terminations. Foam material must not absorb water.

2.2.1.2 Rib Closure

Aluminum, closed-cell or solid-cell synthetic rubber, neoprene or polyvinyl chloride pre-molded to match configuration of rib opening.

Material for closures must not absorb water.

2.2.2 Fasteners

Series 300 stainless steel with composite metal and neoprene composition washers. Fasteners for attachment to structural supports and fasteners for attachment of panels must be as approved and in accordance with manufacturer's recommendation. Unless specified otherwise herein, fasteners must be either self-tapping screws, bolts and nuts, or self-locking bolts. Design fastening system to withstand design loads indicated. Fasteners must not be over-torqued and must develop full capacity of attachment clips. **Finish exposed rivets and fasteners to match substrate colors encountered.**

2.2.2.1 Screws

Provide not less than **No. 14** diameter for self-tapping type and not less than **No. 12** diameter for self-drilling and self-tapping.

2.2.2.2 Bolts

Provide not less than **1/4 inch** diameter, shouldered or plain shank as required, with proper nuts.

2.2.2.3 Rivets

Blind rivets must be aluminum with **3/16 inch** nominal diameter shank or stainless steel with **1/8 inch** nominal diameter shank. Rivets must be threaded stem type if used for other than fastening trim. Rivets with hollow stems must have closed ends.

2.2.3 Sealant

Elastomeric type containing no oil or asphalt. Exposed sealant must cure to a rubberlike consistency. Concealed sealant must be the non-hardening type. Seam sealant must be factory-applied, non-skinning, non-drying, and must conform to the roofing manufacturer's recommendations. Do not use silicone-based sealants in contact with finished metal panels and components unless approved otherwise by the Contracting Officer.

2.2.4 Sealant Tape

Polyvinyl chloride closed cell foam tape or composed of 99 percent solids in a base of butyl polyisobutylene rubber with the following properties and characteristics:

- a. Webbing and Elongation: 100 percent minimum at **77 degrees F**
- b. Adhesion: Excellent to surfaces used
- c. U-V light exposure: No effect
- d. Ozone: No effect
- e. Weathering: 1000 hours in QUV Test Apparatus - Excellent, no cracking, bleeding, or significant changes.
- f. Moisture Transmission: 0.05 to 0.15 grams per **100 square inches** in 24 hours.

- g. Service Temperature Tests: Bending over 1/2 inch mandrel at minus 60 degrees F with no cracking. Expose sealed typical metal lap joint to plus 350 degrees F for 24 hours with no significant loss of original properties.
- h. Reaction to Metals: Non-corrosive to aluminum

PART 3 EXECUTION

3.1 EXAMINATION

Do not use building construction materials that show visible evidence of biological growth.

Examine surfaces to receive standing seam aluminum roofing and flashing. Provide plumb and true surfaces, clean, even, smooth and as dry as possible. Ensure that surfaces are free from defects and projections which might affect the installation. Report unsuitable conditions to Contracting Officer.

3.2 PROTECTION OF DISSIMILAR METALS

Where an aluminum component is in contact with, fastened to, or contacted by drainage from dissimilar metals other than stainless steel, give such dissimilar metals one of the following treatments:

- a. A heavy brush coat of primer followed by two coats of aluminum metal and masonry paint.
- b. A heavy coat of alkali-resistant bituminous paint.
- c. Separate contact surfaces with non-absorptive tape or gasket.

3.2.1 Contact with Masonry

Where aluminum is in contact with masonry, concrete, or plaster, apply a heavy coat of alkali-resistant bituminous paint.

3.2.2 Contact with Wood

Where aluminum is in contact with wood or other absorptive material subject to wetting, or with wood treated with a preservative not compatible with aluminum, seal joints with sealing compound and apply one heavy brush coat of aluminum pigmented bituminous paint.

3.3 INSTALLATION

Install in accordance with approved manufacturer's erection instructions shop drawings, and diagrams, except as specified otherwise herein. Provide panels in full and firm contact with clips. Obtain approval prior to installation on prefinished panels cut in the field, and factory applied coverings or coatings that were repaired after being abraded or damaged during handling or installation. Make repairs with material of same color as weather coating. Completely seal openings through panels. Correct defects or errors in materials in an approved manner. Replace materials which cannot be corrected in an approved manner with new materials. Provide molded closure strips where indicated and where necessary for weathertight construction. Use shims as required to ensure

clip line is true. Use a spacing gage at each row of panels to ensure that panel width is not stretched or shortened.

3.3.1 Roof Panels

Apply roofing panels with standing seams parallel to slope of roof. Provide roofing panels in full lengths from ridge to eaves (top to eaves on shed roofs), with no transverse joints except at the junction of ventilators, curbs, skylights, chimneys, and similar openings. Form interlocking rib type panel seams in the field with an automatic mechanical seamer approved by the manufacturer. Attach panels to structure with concealed clips which are incorporated into the panel seams. Clip attachment must allow roof to move freely and independently of the structure, except at fixed points as indicated.

3.3.2 Flashings

Provide flashing and related closures and accessories in connection with preformed metal panels and as necessary to provide a weathertight installation. Install flashing to ensure positive water drainage away from roof penetrations. Flash and seal roof at ridge, eaves and rakes, at projections through roof, and elsewhere as necessary. Accomplish placement of closure strips, flashing, and sealing material in an approved manner that will ensure complete weathertightness. Details of installation which are not indicated must be in accordance with the [NRCA CONDET](#), [SMACNA 1793](#), [AA ASM-35](#), panel manufacturer's printed instructions and details of the approved shop drawings. Installation must allow for expansion and contraction of flashing.

3.3.3 Flashing Fasteners

Fastener spacings must be in accordance with the panel manufacturer's recommendations and as necessary to withstand the indicated design loads. Install fasteners in roof valleys as recommended by the manufacturer of the panels. Install fasteners in straight lines within a tolerance of [1/2 inch](#) in the length of a bay. Drive exposed penetrating type fasteners normal to the surface and to a uniform depth to seat gasketed washers properly and drive so as not to damage factory applied coating. Exercise extreme care in drilling pilot holes for fastenings to keep drills perpendicular and centered. Do not drill through sealant tapes. After drilling, remove metal filings and burrs from holes prior to installing fasteners and washers. Torque used in applying fasteners must not exceed that recommended by the manufacturer. Remove panels deformed or otherwise damaged by over-torqued fastenings, and provide new panels.

3.3.4 Closure/Closure Strips

Set closure/closure strips in joint sealant material.

3.4 CLEANING

Clean exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs on completion to prevent discoloration and harm to the panels and flashing. 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 must be free of dents, creases, waves, scratch marks, and solder or weld marks.

3.5 MANUFACTURER'S FIELD INSPECTION

Manufacturer's technical representative must visit the site as necessary during the installation process to assure panels, flashings, and other components are being installed in a satisfactory manner. Manufacturer's technical representative must perform a field inspection during the first square of roof panel installation and at substantial completion prior to issuance of warranty, as a minimum, and as otherwise requested by the Contracting Officer. Each inspection visit must include a review of the entire installation to date. After each inspection, submit a report, signed by the manufacturer's technical representative, to the Contracting Officer noting the overall quality of work, deficiencies and any other concerns, and recommended corrective actions in detail. Notify Contracting Officer a minimum of 2 working days prior to site visit by manufacturer's technical representative.

3.6 COMPLETED WORK

Completed work must be plumb and true without oil canning, dents, ripples, abrasion, rust, staining, or other damage detrimental to the performance or aesthetics of the completed roof assembly.

3.7 INFORMATION CARD

For each roof, provide a typewritten card, laminated in plastic and framed for interior display or a photoengraved 0.032 inch thick aluminum card for exterior display. Card to be 8 1/2 by 11 inches minimum and contain the information listed on Form 1 at end of this section. Install card near point of access to roof, or where indicated. Send a photostatic paper copy to NAVFAC Washington, Building 2, Washington Navy Yard, Washington, DC 20374-2121.

3.8 FORM ONE

FORM 1 - PREFORMED STEEL STANDING SEAM ROOFING SYSTEM COMPONENTS

1. Contract Number:
2. Building Number & Location:
3. NAVFAC Specification Number:
4. Deck/Substrate Type:
5. Slopes of Deck/Roof Structure:
6. Insulation Type & Thickness:
7. Insulation Manufacturer:
8. Vapor Retarder: ()Yes ()No
9. Vapor Retarder Type:
10. Preformed Steel Standing Seam Roofing Description:
 - a. Manufacturer (Name, Address, & Phone No.):
 - b. Product Name:
 - c. Width:
 - d. Gage:
 - e. Base Metal:
 - f. Method of Attachment:
11. Repair of Color Coating:
 - a. Coating Manufacturer (Name, Address & Phone No.):
 - b. Product Name:
 - c. Surface Preparation:
 - d. Recoating Formula:
 - e. Application Method:
12. Statement of Compliance or Exception: _____

13. Date Roof Completed:
14. Warranty Period: From _____ To _____
15. Roofing Contractor (Name & Address):
16. Prime Contractor (Name & Address):

Contractor's Signature _____ Date:

Inspector's Signature _____ Date:

-- End of Section --

SECTION 07 84 00

FIRESTOPPING
05/10, CHG 1: 08/13

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; do not allow firestopping material to interfere with the required movement of the joint.
- c. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and 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 E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2020) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E814	(2013a; R 2017) Standard Test Method for Fire Tests of Penetration Firestop Systems
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

FM GLOBAL (FM)

FM 4991

(2013) Approval of Firestop Contractors

FM APP GUIDE

(updated on-line) Approval Guide
<http://www.approvalguide.com/>

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC

(2021) International Building Code

UNDERWRITERS LABORATORIES (UL)

UL 723

(2018) UL Standard for Safety Test for
Surface Burning Characteristics of
Building Materials

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 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. Locate cast-in-place firestop devices and install in place before concrete placement. Install pipe, conduit or cable bundles through cast-in-place device after concrete placement but before area is concealed or made inaccessible. Firestop material must 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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping System; G

SD-03 Product Data

Firestopping Materials; G

SD-06 Test Reports

Inspection; G

SD-07 Certificates

Inspector Qualifications

Firestopping Materials

Installer Qualifications; G

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 must be a trained representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures. Obtain and submit installer's written certification of training, and retain proof of certification for duration of firestop installation.

1.5.2 Inspector Qualifications

The inspector must have a minimum of two years experience in construction field inspections of firestopping systems, products, and assemblies. The inspector must be completely independent of, and divested from, the installer, the manufacturer, and the supplier of any material or item being inspected. The inspector must not be a competitor of the installer, the contractor, the manufacturer, or supplier of any material or item being inspected. Include in the qualifications submittal a notarized statement assuring compliance with the requirements stated herein.

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, submit a manufacturer's engineering judgment, derived from similar UL system designs or other tests 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

Provide material that has 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**. Provide an approved firestopping material as listed in **UL Fire Resistance** or by a nationally recognized testing laboratory.

2.2.2 Toxicity

Provide material that is nontoxic and carcinogen free to humans at all stages of application or during fire conditions and does not contain hazardous chemicals or require harmful chemicals to clean material or equipment.

2.2.3 Fire Resistance Rating

Firestop systems must 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 must 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, must provide "F", "T" and "L" fire resistance ratings in accordance with **ASTM E814** or **UL 1479**. Provide fire resistance ratings as follows:

2.2.3.1.1 Penetrations of Fire Resistance Rated Walls and Partitions

F Rating = Rating of wall or partition being penetrated.

2.2.3.1.2 Penetrations of Fire Resistance Rated Floors, Floor-Ceiling Assemblies and the Ceiling Membrane of Roof-Ceiling Assemblies

F Rating = Rating of wall or partition being penetrated, T Rating = Rating of wall or partition being penetrated hour. Where the penetrating item is outside of a wall cavity the F rating must be equal to the fire resistance rating of the floor penetrated, and the T rating must be in accordance with the requirements of ICC IBC.

2.2.3.1.3 Penetrations of Fire and Smoke Resistance Rated Walls, Floors, Floor-Ceiling Assemblies, and the ceiling membrane of Roof-Ceiling Assemblies

F Rating = Rating of wall or partition being penetrated hour, T Rating = Rating of wall or partition being penetrated hour and L Rating = <10 cfm/sf where L rating is required.

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 must be the same as the construction in which they occur. Provide construction joints and gaps 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. Provide curtain wall joints 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 must meet the cycling requirements of ASTM E1399/E1399M or UL 2079. Provide a minimum class II movement capability for 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.

2.2.4 Material Certification

Submit certificates attesting that firestopping material complies with the specified requirements. Provide certification of compliance with UL 1479 for all intumescent firestop materials used in through penetration systems.

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

Cut and remove thermal insulation 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 30 00 HVAC AIR DISTRIBUTION. 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

Seal cabling for data and communication applications with re-enterable firestopping products and devices as indicated.

3.2.3.1 Re-Enterable Devices

Provide firestopping devices that are pre-manufactured modular devices, containing built-in self-sealing intumescent inserts. 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. Allow for cable moves, additions or changes. Provide devices 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, do not cover or enclose the firestopped areas 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; record type 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 07 92 00

JOINT SEALANTS

08/16, CHG 3: 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.

ASTM INTERNATIONAL (ASTM)

ASTM C509	(2006; R 2021) Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C734	(2015; R 2019) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C919	(2022) Standard Practice for Use of Sealants in Acoustical Applications
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
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 D217	(2019b) Standard Test Methods for Cone Penetration of Lubricating Grease
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants; G

Primers; G

Bond Breakers; G

Backstops; G

SD-06 Test Reports

Field Adhesion; G

SD-07 Certificates

Indoor Air Quality For Interior Sealants; S

Indoor Air Quality For Interior Floor Joint Sealants; S

Indoor Air Quality For Interior Acoustical Sealants; S

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.

2.1.1 Interior Sealants

Provide ASTM C920, Type S or M, Grade NS, Class 12.5, Use NT. 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.	As selected
c. Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed.	As selected
d. Joints between edge members for acoustical tile and adjoining vertical surfaces.	As selected
e. Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted.	As selected
f. Joints formed where non-planar tile surfaces meet.	As Selected
g. Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.	As selected
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 new and existing exterior masonry walls.	As selected

LOCATION	COLOR
c. Expansion and control joints.	As selected
d. Interior face of expansion joints in exterior concrete or masonry walls where metal expansion joint covers are not required.	As selected
e. Voids where items pass through exterior walls.	As selected
f. Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels.	As selected
g. Metal-to-metal joints where sealant is indicated or specified.	As selected
h. Joints between ends of fascia, flashings, and adjacent walls.	As selected

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
a. Control and expansion joints in floors, slabs, ceramic tile, and walkways.	As selected

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](#).

2.2 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 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, round cross section for cellular rubber sponge backing.

2.4.2 Synthetic Rubber

Provide in accordance with [ASTM C509](#), Option I, Type I preformed 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 neoprene backing.

2.4.4 Butyl Rubber Based

Provide in accordance with [ASTM C1311](#), from a single component, with solvent release. color as selected from manufacturer's full range of color choices.

2.4.5 Silicone Rubber Base

Provide in accordance with [ASTM C920](#), from a single component, with solvent release, Non-sag, Type [S](#), Grade [NS](#), Class 25. Color as selected

from manufacturer's full range of color choices.

2.5 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer and in accordance with environmental requirements herein. Protect adjacent aluminum surfaces from solvents. 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 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 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.

3.3 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:

<u>JOINT WIDTH</u>	<u>JOINT DEPTH</u>	
	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 wood, concrete, masonry, stone:		
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
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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 08 11 13

STEEL DOORS AND FRAMES

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 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 (2022a) 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)

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.115 (2016) Hardware Preparation in Steel Doors
and Steel Frames

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (2022) Standard for Fire Doors and Other
Opening Protectives

NFPA 252 (2022) Standard Methods of Fire Tests of
Door Assemblies

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR 113 (2013; R2018) Standard Practice for
Determining the Steady-State Thermal
Transmittance of Steel Door and Frame
Assemblies

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

SDI/DOOR A250.11 (2012) Recommended Erection Instructions
for Steel 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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval.. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G

Frames; G

Accessories

Schedule of Doors; G

Schedule of Frames; G

SD-03 Product Data

Doors; G

Recycled Content for Steel Door Product; S

Frames; G

Recycled Content for Steel Frame Product; S

Accessories

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 DOOR HARDWARE. 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.

2.1.1 Classification - Level, Performance, Model

2.1.1.1 Maximum Duty Doors

SDI/DOOR A250.8, Level 4, physical performance Level A, Model 2 with core construction as required by the manufacturer 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 board insulation.

2.2 ACCESSORIES

2.2.1 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.

2.3 INSULATION CORES

Provide insulating cores at all exterior doors, 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.

2.4 STANDARD STEEL FRAMES

SDI/DOOR A250.8, Level 4 for exterior doors and Level 3 for interior doors .
Form frames to sizes and shapes indicated, with welded corners. .
Provide frame product that uses a minimum of 25 percent recycled content.
Provide data indicating percentage of recycled content for steel frame product.

2.4.1 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.

2.4.2 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated not lighter than 18 gage.

2.4.2.1 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;

2.4.2.2 Floor Anchors

Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member.

2.5 FIRE DOORS AND FRAMES

Provide fire doors and frames in accordance with NFPA 80 and this specification.

2.5.1 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.

2.5.2 Astragal on Fire Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements.

2.6 EXTERIOR FRAMES

Provide thermal insulation in all exterior frames. Provide frames of a minimum Level 4, with frames of a minimum thickness of 0.067 inch, 14 gage.

2.7 HARDWARE PREPARATION

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. Punch door frames, with the exception of frames that will have weatherstripping, to receive a minimum of two rubber 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.

2.8 FINISHES

2.8.1 Hot-Dip Zinc-Coated and Factory-Primed Finish

Fabricate doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A924/A924M and 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.

2.8.2 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.

2.9 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. Design frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive caulking compound.

2.10 PROVISIONS FOR GLAZING

Scheduled interior doors receive 0.25 inch glass and scheduled exterior doors receive 1 inch insulated glass composites. Glass is 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.

3.1.2 Doors

Hang doors in accordance with clearances specified in [SDI/DOOR A250.8](#). After erection and glazing, clean and adjust hardware.

3.2 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 --

SECTION 08 14 00

WOOD DOORS

08/16, CHG 1: 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 in the text by the basic designation only.

AMERICAN FOREST FOUNDATION (AFF)

ATFS STANDARDS (2015) American Tree Farm System Standards of Sustainability 2015-2020

ASTM INTERNATIONAL (ASTM)

ASTM E90 (2009; R2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

ASTM E2226 (2015; R 2019b) Standard Practice for Application of Hose Stream

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (2022) Standard for Fire Doors and Other Opening Protectives

NFPA 252 (2022) Standard Methods of Fire Tests of Door Assemblies

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

UNDERWRITERS LABORATORIES (UL)

UL 10B (2008; Reprint May 2020) Fire Tests of
Door Assemblies

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G

Submit drawings or catalog data showing each type of door unit .
Indicate within drawings and data the door types and construction,
sizes, thickness, and glazing.

SD-03 Product Data

Doors; G

Recycled Content for Door Cores; S

Accessories

Water-resistant Sealer

Sample Warranty

Sound Transmission Class Rating; G

Fire Resistance Rating; G

SD-04 Samples

Door Finish Color; G

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 Grade

Certified Sustainably Harvested Flush Wood Doors; S

Indoor Air Quality for Particleboard and Agrifiber Door Cores: S

SD-11 Closeout Submittals

Warranty

1.3 CERTIFICATIONS

1.3.1 Certified Wood Grades

Provide **certificates of grade** from the grading agency on acoustical doors and fire 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.

1.5 WARRANTY

Warrant doors free of defects as set forth in the door manufacturer's standard door warranty.

PART 2 PRODUCTS

2.1 DOORS

Provide doors of the types, sizes, and designs indicated free of urea-formaldehyde resins.

2.1.1 Flush Doors

Conform to ANSI/WDMA I.S.1A for flush doors. 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. 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 good grade white oak. Hardwood veneers must be quarter sliced. 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 50 when tested in accordance with ASTM E90. Reference 08 34 73 SOUND CONTROL DOOR ASSEMBLIES.

2.1.3 Composite-Type Fire Doors

Provide doors specified or indicated to have a fire resistance rating conforming to the requirements of UL 10B, ASTM E2226, or NFPA 252 for the class of door indicated. Affix a permanent metal label with raised or incised markings indicating testing agency's name and approved hourly fire rating to hinge edge of each door.

Incorporate factory installed edge seals into door constructions certified in accordance with Category A, positive pressure fire door testing. Assemblies are Category G gasketing. Provide gasketing complying with NFPA 80 for fire rated openings encountered. Gasketing complies with ANSI

156.22, UL 1784 and UL 10C. Door pairs receive steel edges and astragals or concealed intumescent seals.

2.2 ACCESSORIES

2.2.1 Door Light Openings

Provide glazed openings with the manufacturer's standard wood moldings. Provide moldings for doors to receive natural finish of the same wood species and color as the wood face veneers. Use lip type moldings for flush doors.

2.2.2 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 Quality and Construction

Identify the standard on which the construction of the door was based and identify doors having a Type I glue bond.

2.3.2 Adhesives and Bonds

ANSI/WDMA I.S.1A. Use TType II bond for interior doors. Provide a nonstaining adhesive on doors with a natural finish.

2.3.3 Prefitting

Provide 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 and providing necessary beaded openings for glass. Provide the door manufacturer with the necessary hardware samples, and frame and hardware schedules to coordinate the work.

2.3.4 Finishes

2.3.4.1 Field Painting

Factory seal doors. Door finish color is stained.

2.3.4.2 Factory Finish

At the contractor's option, 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, closed 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.

2.3.5 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**.
- b. **Hinge loading resistance:** Averages of ten test samples not less than Heavy Duty doors: 475 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**.

3.1.1 Fire Doors

Install fire doors in accordance with **NFPA 80**. Do not paint over labels.

-- End of Section --

SECTION 08 34 73

SOUND CONTROL DOOR ASSEMBLIES

11/19, CHG 1: 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.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.3/D1.3M (2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M (2019) Standard Specification for Carbon Structural Steel

ASTM A108 (2013) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

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 C143/C143M (2020) Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C476 (2020) Standard Specification for Grout for Masonry

ASTM C1036 (2021) Standard Specification for Flat Glass

ASTM D1056 (2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber

ASTM E90 (2009; R2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

ASTM E336 (2020) Standard Test Method for Measurement of Airborne Sound Attenuation

between Rooms in Buildings

ASTM E413 (2022) Classification for Rating Sound Insulation

ASTM E1289 (2008; R 2022) Standard Specification for Reference Specimen for Sound Transmission Loss

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (2022) Standard for Fire Doors and Other Opening Protectives

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 10C (2016; Reprint May 2021) UL Standard for Safety Positive Pressure Fire Tests of Door Assemblies

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

SD-03 Product Data

Wood Sound Retardant Doors; G

Door Frames; G

Door Hardware; G

Door Frame Sound Infill; G

Vision Panels; G

Intumescent Seals and Gasketing; G

Thresholds; G

SD-06 Test Reports

Acoustical Tests; G

Air Infiltration Tests; G

Positive Pressure Tests; G

SD-07 Certificates

Wood Sound Retardant Doors; G

Door Frames; G

Door Hardware; G

Vision Panels; G

Intumescent Seals, Gasketing and Door Bottoms; G

Thresholds; G

Assembly Test Reports

1.3 QUALITY CONTROL

Ensure work within this section is designed and furnished by one manufacturer, who has been engaged in the manufacture of Sound Retardant Wood Swinging Door systems for at least five years prior to the start of this work.

Provide acoustic assemblies manufactured by a single source specializing in the production of this type work for a minimum of five years.

1.3.1 Compliance and Labeling

1.3.1.1 Compliance with Accessibility Requirements

Americans with Disabilities Act/Architectural Barriers Act (ADA/ABA)
36 CFR 1191

Accessibility Guidelines for Buildings and Facilities (ADAAG) 36 CFR 1191

1.3.1.2 Category A Positive Pressure Fire Door Construction

Where requirements for positive pressure are met, include for doors all requirements as part of the door construction per Category A guidelines as published by ITS/Warnock-Hersey. Intumescent is not allowed on the frame. Applying smoke gasketing around the perimeter of the frame to meet the "S" smoke rating is permissible in instances where smoke control is required. Submit Certificate for intumescent seals, gasketing and door bottoms.

1.3.1.3 Labeling

Ensure all positive pressure door assemblies carry the fire label for the complete opening, clearly identifying the:

a. Manufacturer

- b. Third party testing and certification agency
- c. Fire door rating
- d. Installation limitations
- e. Compatible frame, hardware component ratings
- f. Compatible lite or vision panel component ratings
- g. Required building code information, including temperature and smoke rating
- g. STC rating if required.

Indicate fire-ratings of applicable components. Provide documentation of ABA/ADA accessibility compliance of applicable components, as required by 36 CFR 1191 Appendix D - Technical.

1.4 DELIVERY, STORAGE, AND HANDLING

Ship all doors in the manufacturer's undamaged individual cartons, securely bundled and wrapped with moisture-resistant covers and stored in accordance with the manufacturer's printed instructions in a dry, clean, and ventilated area.

Deliver and store wood doors in the building following the installation of concrete, terrazzo, plaster, or other wet materials, and only after the building has dried out and has a roof.

Store all materials on planks in a dry location. Store doors and frames vertically with an airspace between. Store doors on the edge to eliminate any potential damage to the door bottom seal. Cover all material to protect from damage but in a manner to allow proper circulation.

Maintain relative humidity in the building between 30 and 65 percent. Maintain the ambient temperature at 60 degrees F minimum at the time of installation of wood doors.

Perform final adjustment of seals when temperatures and humidity conditions replicate the interior conditions that will exist when the building is occupied.

1.5 WARRANTY

Manufacturer's warranty for 5 years from date of supply, covering material and workmanship. Failures include, but are not limited to, the following:

- a. Failure to meet sound rating requirements
- b. Faulty operation of sound seals
- c. Deterioration of metals, metal finishes, and other materials beyond normal use or weathering.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide sound retardant door assemblies of the thickness, width, and height indicated, complete with perimeter seals, seal housings, gasketing, automatic door bottoms, thresholds, door frames, and astragals as required to conform to the specified STC per [ASTM E90](#) and [ASTM E1289](#).

Submit [fabrication drawings](#) for Wood Sound Retardant Doors, Door Frames and Door Frame Sound Infill.

Submit certificates showing conformance with the referenced standards in this section, and manufacturer's catalog data including STC ratings and UL fire rating, where applicable, for the following items: [Wood sound retardant doors](#); [door frames](#); [door hardware](#); [vision panels](#); [intumescent seals and gasketing](#) and [thresholds](#).

Provide assemblies that are complete with metal frame, wood door(s), sealing system, and Cam-lift hinges (when required). If vision lights are specified for doors, provide metal loose stops and field install glass and glazing when shipped separately.

2.1.1 Design Requirements

2.1.1.1 Door Design

Provide sound Retardant Wood Swinging Doors that are a [1-3/4-inch](#) thickness construction with sizes as indicated on drawings. No visible seams are permitted on door faces. Provide face gauges, internal sound retardant core and perimeter door edge construction per manufacturer's standard for the specified STC rating. No lead or asbestos is permitted in door construction to achieve STC performance. Provide face veneer species cut and color as selected from manufacturer's full range of available colors and patterns. No lead or asbestos is permitted in door construction to achieve performance requirements.

2.1.1.2 Frame Design

Provide sound Retardant Metal Frames conforming to [ASTM A1008/A1008M](#), not less than [0.0747-inch](#) thick, and free from pitting, scale, stretcher strains, fluting, and surface defects with integral trim and shipped with temporary spreader. Knockdown frames are not acceptable.

Provide frames with [2 inch](#) faces, profiles and dimensions as indicated, with mitered reinforced corners, welded the full depth of frame and trim, with exposed surfaces ground smooth and flush. Close contact edges to hairline joints.

2.1.2 Performance Requirements

2.1.2.1 STC (Sound Transmission Classification) Rating

Provide doors with an STC of at least [50](#).

2.2 FABRICATION

Clean and sand to smooth finish all doors to remove handling and storage marks, raised grain, minor surface marks and abrasions which are to

receive a job site finish. Door veneer species and finish is to match that provided in 08 14 00 WOOD DOORS.

2.2.1 Wood Sound Retardant Doors

Construct doors with wood veneer facings separated by a core construction designed to meet the required STC. Test, rate, and label in accordance with ASTM E90.

Comply with the NAAWS 3.1, "Guide Specifications and Quality Certification Program," for custom grade constructions and to the requirements specified.

Perform beveling, prefitting, machining, mortising, and routing for hardware, perimeter seals, and door bottom cutouts at the mill.

Furnish custom grade door facings with standard thickness face veneers conforming to NAAWS 3.1, Type 1 for stain and transparent job site-applied finish.

2.2.1.1 Faces

Single-ply wood veneer not less than 1/50 inch thick.

- a. Species: White oak.
- b. Cut: Quarter sliced.
- c. Match between Veneer Leaves: Slip match.
- d. Assembly of Veneer Leaves on Door Faces: Center-balance match.
- e. Pair and Set Match: Provide for doors hung in same opening.
- f. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.

2.2.2 Door Finishing

Conform factory finishing of Sound Retardant Wood Swinging Doors in accordance with AWI Quality Standards. At the contractor's option, provide factory finish of a water-base stain and ultraviolet (UV) cured polyurethane sealer to comply with EPA Title 5 guidelines for Volatile Organic Compound (VOC) emissions limitations. Conform finish to meet or exceed performance standards of NAAWS 3.1 catalyzed polyurethane. Factory finishing must match the finish provided in 08 14 00 WOOD DOORS

2.3 COMPONENTS

2.3.1 Frames

Construct frames for Sound Retardant Wood Swinging Doors from formed sheet steel or structural shapes and bars. Provide sheet steel that is commercial quality, level, cold rolled steel conforming to ASTM A1008/A1008M or hot rolled, pickled and oiled steel conforming to ASTM A1011/A1011M. Comply steel shapes with ASTM A36/A36M and steel bars with ASTM A108, Grade 1018.

2.3.2 Door Frame Sound Infill

Grout: Comply with ASTM C476, with a slump of not more than 4 inches as measured according to ASTM C143/C143M.

Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15 mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3.3 Hardware Reinforcements

Factory mortise, reinforce, drill and tap frames for all mortise hardware as required by hardware manufacturer's template. Provide necessary reinforcement plates as required for surface mounted hardware; installer to perform all field drilling and tapping. Provide dust cover boxes on all frame mortises. Provide minimum thicknesses as follows:

- a. Butts, 3/16 inch
- b. Lock strike, 0.1196 inch
- c. Surface applied hardware 0.0747 inch

2.3.4 Jamb Anchors

Provide number and spacing of anchors as follows:

2.3.4.1 Stud-Wall Type

Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

- a) Three anchors per jamb up to 60 inches in height.
- b) Four anchors per jamb from 60 to 90 inches in height.
- c) Five anchors per jamb from 90 to 96 inches in height.
- d) Five anchors per jamb plus one additional anchor per jamb for each 24 inches, or fraction thereof, more than 96 inches in height.
- e) Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.

2.3.5 Door Hardware

Provide the following STC related hardware with the door; cam-lift hinges, perimeter seals, door bottoms, thresholds, hardware standoff brackets and related hardware appurtenances.

Include on Fabrication drawings a finish hardware schedule for each door and a hollow metal door frame schedule for each door indicating profile, dimensions, hardware reinforcement, and frame anchorage. Also indicate perimeter seals, door-bottom devices and other hardware items that are assembled in the shop.

2.3.6 Vision Panels

Furnish doors with vision panels complete with glazing. Provide 0.0747 inch steel or wood frames, moldings, and stop to match the door finish, with profile indicated. Assemble with mitered corners and flush joints, and secured with countersunk phillips-head screws.

Provide either a single thickness of acoustical plate glass laminated to an inner face of water-clear plastic or multiple thicknesses of 1/4 inch plate glass, clear or patterned as indicated, and set in glazing gaskets and frames as required to meet the specified STC.

Provide glass to conform to ASTM C1036, Type I, Class 1. Provide acoustical plate glass that has been tested and rated in accordance with ASTM E90, with an STC of not less than 36 and a minimum thickness of 9/32 inch.

2.3.7 Head and Jamb Seals

Provide a closed-cell, expanded cellular rubber Seal material conforming to ASTM D1056, Type S, Grade SBE-42 or SCE-42 for heads, jambs, and door bottoms.

Install seals in formed steel or extruded aluminum shapes designed to receive and hold seals and to provide concealed adjustable attachment to door frames. Provide concealed adjustment screws that are not more than 12 inches on center and provide at least 3/8 inch adjustment.

2.3.8 Door Bottoms

Neoprene or silicone gasket held in place by metal housing; mortised into bottom edge of door.

2.3.8.1 Automatic Door Bottoms

Neoprene or silicone gasket, held in place by metal housing, that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.

Mounting: Mortised or semimortised into bottom of door as required by testing to achieve STC rating indicated.

2.3.9 Thresholds

Provide metal thresholds where indicated. Provide thresholds that are extruded aluminum, 6063-T5 alloy, mill finish, not less than 1/8 inch thick, with integral seal grooves formed to the indicated section.

Provide flat, smooth, unfluted thresholds as recommended by manufacturer; fabricated from aluminum.

a. Finish: Clear anodic finish.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

2.4.1 Sound Transmission Classification

Provide test reports prepared by a nationally recognized, independent laboratory for Acoustical Tests, Air Infiltration Tests, Wind Loading

Tests, and Water Leakage Tests indicating that the sound transmission classification (STC) of the proposed door, based on tests at 16 third-octave band frequencies from 125 to 4,000 hertz, is no less than the specified STC when tested in accordance with [ASTM E90](#), and that the door tested is hung in substantially the type of wall and frame as indicated and is fully operable with hardware and perimeter seals installed.

2.4.2 Positive Pressure

Provide test reports, prepared by a nationally recognized, independent laboratory for Positive Pressure Tests, for all fire rated door assemblies, including Intumescent Seals, Gasketing, and Door Bottoms.

2.4.3 Cam Lift Hinges

When required to achieve STC, manufacturer to furnish laboratory test data certifying hinges have been cycled a minimum of 1,000,000 while supporting a minimum door weight of [350 pounds](#).

Full-mortise template type that raises the door [1/2 inch](#) when door is fully open; with hardened pin; fabricated from stainless steel.

2.4.4 Guarantee

Provide written guarantee that each door delivered to the project is equal in construction, sound transmission classification (STC), and positive pressure test rating where applicable, with appropriate labeling and markings, to that of the sample door tested. Clearly state in written guarantee that each door assembly, when installed in accordance with the manufacturer's printed instructions, has an in-place STC within 3 decibels of the specimen tested. Submit the following test data and Certificates with the written Guarantee:

- c. [Acoustical Tests](#)
- d. [Air Infiltration Tests](#)
- e. [Positive Pressure Tests](#)

PART 3 EXECUTION

3.1 PREPARATION

Upon receipt of material, thoroughly inspect all frames, doors and accessories. Verify quantities and tag numbers according to the packing list provided. Report all discrepancies, deficiencies and/or damages immediately to Contracting Officer.

Prior to installation check all doors and frames for correct size and swing. Verify that frames are plumb, square and aligned without twist in accordance with tolerances published by NAAMM/HMMA and SDI.

3.1.1 Frame Painting and Cleaning

Clean thoroughly all surfaces of all mill scale, rust, oil, grease, dirt, and other foreign materials before the application of the shop coat of paint.

Apply one shop coat of rust inhibitive metallic oxide or synthetic resin

primer applied to clean, dry, and prepared surfaces by brush, dipping, or other approved method to provide a continuous minimum dry film thickness of 0.9 mil.

3.2 INSTALLATION

3.2.1 Frame

Install frames plumb and true with not more than 1/32 inch deviation in vertical alignment in 8 feet. Anchor to the wall in accordance with the manufacturer's instructions. Grout frames solid with mortar in masonry, concrete, and plaster wall construction. Spot grout frames in dry wall partitions with mortar at the jamb anchor clips; fill the space between metal frame and stud partition solidly with fiberglass or mineral wool insulation.

Field splices may be required after installation because of shipping limitations. Field weld splices by certified welders per manufacturer's instructions and in accordance with AWS D1.3/D1.3M.

3.2.2 Door

Install and adjust all doors, hardware, and seals in accordance with the approved drawings, hardware schedules, and the printed instructions of the door manufacturer.

Install and adjust perimeter seals and automatic door bottom seals to provide positive compression contact with the entire sealing surface with no gaps, openings, or breaks. Hinges or hardware which distort or pinch the perimeter seal during operation of the door will be rejected.

Install door bottom devices to seal the space between the door bottoms and the finished floor and the space between the seal and seal housing.

Field apply perimeter seal housings with mitered corners and with flush, aligned hairline joints.

Install wood doors and frames in accordance with NFPA 80 and UL 10C.

Install components to manufacturer's written instructions. Coordinate with wall constructions encountered for anchor placement. Set frames plumb, square, level and at correct elevation. Adjust operable parts for correct clearances and function. Install and adjust perimeter and bottom acoustic seals.

3.3 FIELD QUALITY CONTROL

Provide third party testing in accordance with ASTM E336. Verify in writing that installed product performs no less than five (5) ASTC or NIC rating points below the specified laboratory STC rating. Examine, adjust, and retest any installation not meeting that criteria until compliance is obtained.

3.3.1 Testing and Performance

Provide assemblies that are identical to those tested at an independent acoustical laboratory qualified under the National Voluntary Laboratory

Accreditation Program (NVLAP) by the National Institute for Science and Technology (NIST) in accordance with [ASTM E90](#) and [ASTM E413](#). For the [assembly test reports](#) include the laboratory name, test report number and date of test.

3.4 HARDWARE SETS

Heavy Duty, 20 Minute Rated, STC Openings

Door No. 109B, 112B, 125B, 127B, 207B, 209B, 216B, 222B, 224B

HWS-1 *Dormitory, Sleeping, 20 Min, STC 50*

	3 each 4.5 x 4.5 Cam Lift Hinge, A5141	630	
Section 08 71 00	1 each FMC Closer, C02021	630	
Section 08 71 00	1 each Lever Corridor Lock, F90	630	
Section 08 71 00	1 each 7 Pin SFIC, F24, E09241	630	
	1 each 3070 Acoustical Gasket		MIL
	1 each 36" Automatic Door Bottom		MIL
	1 each 36" 3 Inch Saddle Threshold		MIL
Section 08 71 00	1 each Wall Stop, L02251 or	626	
	Floor Stop, L02161		

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 08 41 13

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

08/18, CHG 1: 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.

ALUMINUM ASSOCIATION (AA)

AA DAF45 (2003; Reaffirmed 2009) Designation System
for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 800 (2016) Voluntary Specifications and Test
Methods for Sealants

AAMA 1503 (2009) Voluntary Test Method for Thermal
Transmittance and Condensation Resistance
of Windows, Doors and Glazed Wall Sections

AAMA 2605 (2020) Voluntary Specification,
Performance Requirements and Test
Procedures for Superior Performing Organic
Coatings on Aluminum Extrusions and Panels

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16 (2017; Errata 2018; Supp 1 2018) Minimum
Design Loads and Associated Criteria for
Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM B221 (2021) Standard Specification for Aluminum
and Aluminum-Alloy Extruded Bars, Rods,
Wire, Profiles, and Tubes

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 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

ASTM E783 (2002; R 2018) Standard Test Method for
Field Measurement of Air Leakage Through

Installed Exterior Windows and Doors

ASTM E1105

(2015) Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference

ASTM E1424

(1991; R 2016) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure and Temperature Differences Across the Specimen

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.10

(2017) Power Operated Pedestrian Doors

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC

(2021) International Building Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-P-645

(Rev C; Notice 1) Primer, Paint, Zinc-Molybdate, Alkyd Type

1.2 ADMINISTRATIVE REQUIREMENTS

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 Contractor Quality Control approval 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

Installation Drawings; G

Fabrication Drawings; G

SD-03 Product Data

Finish; G

Recycled Content of Aluminum Material; S

SD-04 Samples

SD-06 Test Reports

Deflection

Air Infiltration

Condensation Resistance and Thermal Transmittance

Water Infiltration

SD-08 Manufacturer's Instructions

Manufacturer's Instructions

SD-11 Closeout Submittals

Manufacturer's Product Warranty

1.4 QUALITY CONTROL

1.4.1 Qualifications

1.4.1.1 Installer Qualifications

Provide documentation of the installer's experience in performing the work specified in this section.

Ensure that the installers are specialized in work similar to that required for this project, and that they are acceptable to product manufacturer.

1.4.1.2 Manufacturer Qualifications

Ensure that manufacturers meet the requirements specified in this section and project drawings.

Ensure that the manufacturer is capable of providing field service representation during construction, approving acceptable installers and approving application methods.

1.4.2 Single-Source Responsibility

When aluminum entrances are part of a building enclosure system, that includes storefront framing, windows, a curtain wall system, and related products, provide building enclosure system products from a single-source manufacturer.

Use a single source manufacturer with sole responsibility for providing design, structural engineering, and custom fabrication for door portal systems and for supplying components, materials, and products. Do not use products provided from numerous sources for assembly at the site. Ensure that the following work items and components are fabricated or supplied by a single source are:

- a. Door assemblies.
- b. Glazed walls.
- c. Door operating hardware as **scheduled**. **Appurenant items are specified and procured in Section 08 71 00 DOOR HARDWARE and conveyed to the glazing trade for installation.**
- d. Glass as specified in Section **08 81 00 GLAZING**.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Ordering

To avoid construction delays, comply with the manufacturer's lead-time requirements and instructions for ordering.

1.5.2 Packing, Shipping, Handling and Unloading

Deliver materials in the manufacturer's original, unopened, undamaged containers with identification labels intact.

1.5.3 Storage and Protection

Store materials in a way that protects them from exposure to harmful weather conditions. Avoid damaging the storefront material and components during handling. Protect storefront material against damage from elements, construction activities, and other hazards before, during, and after storefront installation.

Do not use adhesive papers or sprayed coatings that become firmly bonded when exposed to sunlight. Do not leave coating residue on surfaces.

1.6 PROJECT / SITE CONDITIONS

1.6.1 Field Measurements

Verify actual measurements or openings by taking field measurements before fabrication; record these measurements on shop drawings. To avoid construction delays, coordinate field measurements, and fabrication schedule with construction progress.

1.7 WARRANTY

Provide a written manufacturer's warranty, executed by a company official, warranting against defects in materials and products for 2 years from the date of shipment. Warrant that the door corner construction is for the life of the project. Provide a written installer's warranty, warranting work to be watertight and free from defective materials, defective workmanship, and glass breakage as a result of defective design, and agreeing to replace components that fail within 2 years.

The warranty states the following:

- a. Watertight and airtight system installation is completed within specified tolerances.
- b. The completed installation remains free of rattles, wind whistles and noise caused by thermal movement and wind pressure.
- c. System is structurally sound and free from distortion.
- d. Glass and glazing gaskets will not break or "pop" from frames as a result of design, wind load pressure, movement caused by expansion or contraction, or structural loading.
- e. Glazing sealants and gaskets remain free of abnormal deterioration or dislocation as a result of sunlight, weather, or oxidation.

Provide written warranty stating that the organic coating finish will not fade more than 10 percent or show chalking, yellowing, peeling, cracking, pitting, corroding or variations in color, or gloss deterioration beyond the manufacturer's descriptive standards for 20 years from the shipment date and agreeing to promptly correct defects.

Provide a written thermal integrity warranty for 2 years from ship date against thermal barrier system failure resulting from the following:

- a. Longitudinal and transverse thermal barrier shrinkage.
- b. Thermal barrier cracking.
- c. Structural failure of the thermal barrier material.
- d. Loss of adhesion or loss of prescribed edge pressure on glazing material, resulting in excessive air and water infiltration.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide aluminum entrances, with glass and glazing, door hardware, and components.

Aluminum entrances include impact resistance entrances; wide stile, 6 inch vertical face dimension, 1 3/4 inch depth, for interior structural silicone glaze, for high-traffic/impact-resistant applications.:

2.1.1 Design Requirements for Aluminum (Entrances and Components)

Provide a door portal system designed to withstand the following loads without breakage, loss, failure of seals, product deterioration, or other defects.

- a. Dead and Live Loads: Determined by ASCE 7-16 and calculated in accordance with applicable codes.
- b. Seismic Loads: Design and install the system to comply with the seismic requirements for the project location in accordance with Section 1613 of the International Building Code, ICC IBC.
- c. Wind Loads: Design and install the system so that the effects of wind load acting inward and outward normal to the plane of the wall are in accordance with ASTM E330/E330M. Marine Corps Base Camp Lejeune must resist a 145 mile per hour, Risk Category II, Surface Roughness Category C, Exposure Category C lateral load.
- d. Thermal Loads And Movement:
 - (1) Ambient Temperature Range: 120 degrees F
 - (2) Material Surfaces Range: 180 degrees F
- e. Water and Air Resistance: Provide weatherstripping, exterior gaskets, sealants, and other accessories to resist water and air penetration.

2.1.1.1 Material Standard

ASTM B221; 6063-T5 alloy and tempered.

Provide door stile and rail face dimensions of the entrance doors as follows:

Vertical Stile	Top Rail	Bottom Rail
6 inches	8 inches	10 inches

Provide major portions of the door members at 0.125 inches nominal in thickness and glazing molding at 0.050 inches thick.

2.1.1.2 Recycled Content

Provide aluminum framed entrances and storefronts that have a minimum of 20 percent recycled content based upon the aluminum billet used in the original material. Provide data indicating percentage of recycled content of aluminum material.

2.1.1.3 Sealants

Provide either ethylene propylene diene monomer (EPDM) elastomeric extrusions or thermoplastic elastomer glazing gaskets. Structural silicone sealant is required.

Internal Sealants: Provide sealants that according to the manufacturer will remain permanently elastic, tacky, non-drying, non-migrating, and weather tight.

2.1.1.4 Thermal Barrier

Use a rigid, structural thermal barrier to separate all exterior aluminum from interior aluminum. For purposes of this specification, a structural thermal barrier is defined as a system that transfers shear during bending and, therefore, promotes composite action between the exterior and interior extrusions. Do not use a nonstructural thermal barrier. Ensure that the thermal barrier provides a structural connection between the two sides of the door.

2.2 FABRICATION

Provide the following information when submitting fabrication drawings for custom fabrications:

- a. Indicate elevations, detailed design, dimensions, member profiles, joint locations, arrangement of units, and member connections.
- b. Show the following items:
 - (1) Details of special shapes.
 - (2) Reinforcing.
 - (3) Anchorage system.
 - (4) Interfacing with building construction.

(5) Provisions for expansion and contraction.

(6) Thermal breaks.

- c. Indicate typical glazing details, locations of various types and thickness of glass and internal sealant requirements as recommended by the sealant manufacturer.
- d. Clearly indicate locations of exposed fasteners and joints.
- e. Clearly show where and how the manufacturer's system deviates from Contract drawings and these specifications.

2.2.1 Entrance System Fabrication

Provide door corner construction consisting of mechanical clip fastening, SIGMA deep penetration plug welds and 1 1/8 inch long fillet welds inside and outside all four corners. Provide a hook-in type exterior glazing stop with EPDM glazing gaskets reinforced with non-stretchable cord. Provide an interior glazing stop that is mechanically fastened to the door member and that incorporates a silicone-compatible spacer used with silicone sealant.

Accurately fit and secure joints and corners. Make joints hairline in appearance. Remove burrs and smooth edges. Prepare components with internal reinforcement for door hardware. Arrange fasteners and attachments so that they are concealed from view.

Separate dissimilar metals with protective coating or pre-formed separators to prevent contact and corrosion.

2.2.2 Shop Assembly

Fabricate and assemble units with joints only at the intersection of aluminum members with hairline joints; rigidly secure these units, and seal them in accordance with the manufacturer's recommendations.

2.2.2.1 Welding

Conceal welds on aluminum members in accordance with AWS recommendations or methods recommended by the manufacturer. Members showing welding bloom or discoloration on finish or material distortion will be rejected by the Contacting Officer.

2.2.3 Finish

Before fabrication, clean the units and give them a AA-M-10-C22-A42 (color) anodized finish in accordance with the requirements of the AA DAF45. The finish thickness is A42, 0.7 mil or greater.

Exterior color is bone white as defined in the Marine Corps Base Camp Lejeune Base Exterior Architectural Plan, Rifle Range Historic Area.

- a. Organic Coating (high-performance exterior coating):

- (1) Comply with requirements of AAMA 2605.

- (2) Clean surfaces and pretreat them with a conversion coating before applying 0.3 mil dry-film thickness of epoxy or acrylic primer

according to the recommendations of the finish coat manufacturer.

- (3) Apply a finish coat of 70 percent minimum fluoropolymer resin fused to primed surfaces at the temperature recommended by the manufacturer and at a minimum dry film thickness of 1.0 mil.
- (4) Use a 2-, 3-, or 4-coat system as required for the color selected.

2.2.4 Fabrication Tolerance

Fabricate and assemble units with joints only at intersection of aluminum members with hairline joints; rigidly secure these units, and seal them in accordance with the manufacturer's recommendations.

Fabricate aluminum entrances in accordance with the entrance manufacturer's prescribed tolerances.

2.2.4.1 Material Cuts

Square to 1/32 inch off square, over largest dimension; proportionate amount of 1/32 inch on the two dimensions.

2.2.4.2 Maximum Offset at Consecutive Members

1/64 inch in alignment between two consecutive members in line, end to end.

2.2.4.3 Maximum Offset at Glazing Pocket Corners

1/64 inch between framing members at glazing pocket corners.

2.2.4.4 Joints

Between adjacent members in same assembly: Joints are hairline and square to the adjacent member.

2.2.4.5 Variation

In squaring diagonals for doors and fabricated assemblies: 1/16 inch.

2.2.4.6 Flatness

For doors and fabricated assemblies: plus/minus 1/16 inch of neutral plane.

2.3 MATERIALS

2.3.1 Sealants

Refer to Section 07 92 00 JOINT SEALANTS. Ensure that all sealants conform to AAMA 800.

2.3.2 Glass

Refer to Section 08 81 00 GLAZING.

2.4 ACCESSORIES

2.4.1 Fasteners

Provide stainless steel fasteners in areas where the fasteners are exposed.

Use non-corrosive and compatible fasteners with components being fastened. Do not use exposed fasteners, except where unavoidable for application of hardware.

In areas where fasteners are not exposed, use aluminum, non-magnetic stainless steel, or other materials warranted by the manufacturer.

For exposed locations, provide countersunk Phillips head screws when items with a matching finish are fastened. For concealed locations, provide the manufacturer's standard fasteners.

Provide nuts or washers that have been designed with a means to prevent disengagement; do not deform fastener threads.

2.4.2 Perimeter Anchors

When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

2.4.2.1 Inserts and Anchorage Devices

Provide manufacturer's standard formed or fabricated assemblies, steel or aluminum, of shapes, plates, bars, or tubes. Shop-coat steel assemblies after fabrication with an alkyd zinc chromate primer complying with FS TT-P-645.

2.4.3 Standard Entrance Hardware

2.4.3.1 Weatherstripping

Equip meeting stiles on pairs of doors with an adjustable astragal using wool pile with a polymeric fin.

Provide door weatherstripping consisting of a thermoplastic elastomer weatherstripping on a tubular shape with a semi-rigid polymeric backing.

Provide sill-sweep strips: Provide an EPDM blade gasket sweep strip in an aluminum extrusion applied to the interior exposed surface of the bottom rail with concealed fasteners. (Provide as necessary to meet specified performance tests.)

2.4.3.2 Threshold

Provide an extruded aluminum threshold, one piece per door opening, with ribbed surface.

2.4.3.3 Concealed Leaf Rotons

Concealed leaf roton hinges are heavy duty, complying with ANSI A 156.26, A31031G for high frequency or heavy medium frequency use doors. Provide a hinge side clearance of 0.3125 inches in addition to standard lock stile clearances. Door or frame reinforcement is not required for doors weighing up to 200 pounds. Door weights in excess of 200 pounds require

16 gauge channel frame reinforcement. Hinges are UL listed for 3 Hours.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Site Verification of Conditions

Verify that the condition of substrate previously installed under other sections is acceptable for product installation in accordance with the manufacturer's instructions.

Verify that openings are sized to receive the storefront system and that the sill plate is level in accordance with the manufacturer's acceptable tolerances.

3.2 PREPARATION

Field-verify dimensions before fabricating components for the door portal assembly.

Coordinate the erection of door portal with installation of surrounding glass wall and door assemblies. Ensure that the door portals can provide support and anchorage for assembly components.

3.2.1 Adjacent Surfaces Protection

Protect adjacent work areas and finish surfaces from damage during product installation.

3.2.2 Aluminum Surface Protection

Protect aluminum surfaces from contact with lime, mortar, cement, acids, and other harmful contaminants.

3.3 INSTALLATION

Submit [installation drawings](#) for review and approval.

Install the entrance system in accordance with the [manufacturer's instructions](#) and the AAMA storefront and entrance guide specifications manual. Attach the entrance system to the structure, allowing it to be adjusted to accommodate construction tolerances and other irregularities. Provide alignment attachments and shims to permanently fasten the system to the building structure. Align the assembly so that it is plumb and level, and free of warp and twist. Maintain assembly dimensional tolerances aligning with adjacent work.

Set thresholds in a bed of mastic and secure the thresholds. Protect aluminum members in contact with masonry, steel, concrete, or dissimilar materials using nylon pads or a bituminous coating. Shim and brace the aluminum system before anchoring the system to the structure. Verify that weep holes are open, and the metal joints are sealed in accordance with the manufacturer's installation instructions. Seal metal-to-metal joints using a sealant recommended by the system manufacturer.

3.3.1 Tolerances

Ensure that tolerances for wall thickness and other cross-sectional

dimensions of entrance members are nominal and in compliance with Aluminum Standards and Data, published by the Aluminum Association.

3.3.2 Adjusting

Adjust operating hardware for smooth operation, and as recommended by the manufacturer.

3.3.3 Related Products Installation Requirements

3.3.3.1 Sealants (Perimeter)

Refer to Section 07 92 00 JOINT SEALANTS.

3.3.3.2 Glass

Refer to Section 08 81 00 GLAZING.

3.4 FIELD QUALITY CONTROL

3.4.1 Air Infiltration

Test air infiltration in accordance with ASTM E783

Submit certified test reports showing compliance with specified performance characteristics as follows:

- a. For single-acting offset pivot, butt hung, or continuous geared hinge entrances in the closed and locked position, test the specimen in accordance with ANSI/BHMA A156.10, and ASTM E283 at a pressure differential of 1.57 psf for pairs of doors; ensure that maximum infiltration for a pair of 7 foot by 8 foot entrance doors and frame is 1.2 cfm/square foot.
- b. Ensure the maximum allowable infiltration for a completed storefront system does not exceed 0.06 cfm/square foot when tested in accordance with ASTM E1424 at a differential static pressure of 6.24 psf.

3.4.2 Wind Loads

Provide a completed storefront system capable of withstanding wind pressure loads, normal to the wall plane indicated, as follows:

a. Exterior Walls

- (1) Positive Pressure: 55 psf
- (2) Negative Pressure: 55 psf

3.4.3 Deflection

Submit certified test reports showing that the maximum allowable deflection in a member when tested in accordance with ASTM E330/E330M with allowable stress is L/175 or 3/4 inches maximum.

3.4.4 Condensation Resistance and Thermal Transmittance

Submit certified test reports showing compliance with specified performance characteristics as follows:

a. U-Value Requirements:

- (1) Perform test in accordance with the AAMA 1503 procedure and on the configuration specified therein.
- (2) Thermal Transmittance ("U" Value) maximum 0.65 (6250) BTU/hr/sf/deg F at 15 mph exterior wind.

b. CRF Class Requirements:

- (1) Perform a test in accordance with AAMA 1503.
- (2) Condensation Resistance Factor Requirements (CRF) minimum 60.

3.4.5 Water Infiltration

Submit certified test reports showing that the system is designed to provide no uncontrolled water when tested in accordance with ASTM E1105 at a static pressure of 8 psf.

3.5 ADJUSTING AND CLEANING

3.5.1 Protection

Protect the installed product's finish surfaces from damage during construction. Protect the aluminum storefront system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.

3.5.2 Cleaning

Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions before acceptance remove excess mastic, mastic smears, and other foreign materials. Remove construction debris from the project site and legally dispose of this debris.

3.6 WARRANTY

Submit 3 signed copies of the manufacturer's product warranty for the entrance system as follows:

- a. Stipulate warranty periods as stated in paragraphs describing WARRANTY in Part 1 above.

Ensure that the Warranty's language is identical to the "As Approved" version of the sample warranty submitted to and returned from the Contracting Officer.

3.7 HARDWARE SETS

Door No. 102A, 107A, 128		
HWS-2	Secure Exterior AC BEQ Entrance	
	1 each HD Roton, A31031G	Bone White
Section 08 71 00	1 each FMC Closer, C02231	630
	with spring stop, stop mounted slide	
	track armpush side mount	
Section 08 71 00	1 each Lever Storeroom, F86	630

RR1 Repair by Replacement
MCB Camp Lejeune, NC

Project# P1594
27 April 2023

Section 08 71 00	1 each 7 Pin SFIC, F24, E09241	630	
Section 08 71 00	1 each 40" Drip Ledge	MIL	
	1 each 3070 Weatherstrip		Bone White
	1 each 36" Bottom Sweep		Bone White
	1 each 36" Threshold		MIL
Section 08 71 00	1 each Floor Stop, L02131	626	
Section 08 71 00	1 each Power Supply	600	
Section 08 71 00	1 each Electric Strike	630	
GFGI	1 each Card Reader, Wall Mount		Black

Note: Furnish electric metallic tubing raceway, cabling and a blank stainless steel coverplate to receive Government furnished and installed devices

Note: Coordinate with the Government to support GFGI devices, equipment and programming

Note: GFGI access control equipment is located in Communications 103

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

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.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 701/702	(2011) Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals
AAMA 902	(2016) Voluntary Specification for Sash Balances
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 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
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
------------	---

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2021; TIA 21-1) Life Safety Code

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

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Windows; G

Fabrication Drawings

SD-03 Product Data

Windows; G

Recycled Content of Aluminum Windows; S

Hardware; G

Fasteners; G

Window Performance; G

Thermal-Barrier Windows; G

Mullions; G

Screens; G

Weatherstripping; G

Accessories; G

Adhesives

Thermal Performance; G

SD-04 Samples

Finish Sample

Window Sample

SD-05 Design Data

Structural Calculations for Deflection; G

Design Analysis; G

SD-06 Test Reports

Minimum Condensation Resistance Factor

SD-07 Certificates

Engineer's Qualifications

SD-10 Operation and Maintenance Data

Windows, Data Package 1; G

Submit in accordance with Section 01 78 23 OPERATION AND
MAINTENANCE DATA.

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, mullion details, method and materials for weatherstripping, method of attaching screens, stools, casings, sills, trim, installation details, and other related items.

1.3.3 1.3.4 Sample Requirements

1.3.4.1 Finish Sample Requirements

Submit color chart of standard factory color coatings when factory-finish color coating is to be provided.

1.3.4.2 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.

1.3.5 Engineer's Qualifications and 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. Marine Corps Base Camp Lejeune must resist a 145 mile per hour, Risk Category II, Surface Roughness Category C, Exposure Category C lateral load.

1.3.6 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).

1.3.7 Certification

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 PERFORMANCE REQUIREMENTS

1.5.1 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).

1.5.2 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 double-hung 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.

1.6 DRAWINGS

Submit the [Fabrication Drawings](#) for aluminum window units showing complete window assembly including hardware, weatherstripping, and subframe assembly details.

1.7 WINDOW PERFORMANCE

Aluminum windows must meet the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

1.7.1 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.

1.7.2 Air Infiltration

Air infiltration must not exceed the amount established by [AAMA/WDMA/CSA 101/I.S.2/A440](#) for each window type.

1.7.3 Water Penetration

Water penetration must not exceed the amount established by [AAMA/WDMA/CSA 101/I.S.2/A440](#) for each window type.

1.7.4 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 FEMP designated, and Passive House qualifications as applicable.

1.7.4.1 South-Central Climate

Windows installed within Climate Zone 3 will have a U-Factor of [0.30 BTU/h·ft²·degrees F](#) or less and a SHGC of 0.25 or less.

1.7.5 Life Safety Criteria

Provide windows that conform to [NFPA 101](#) Life Safety Code when rescue and/or second means of escape are indicated.

1.8 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 60 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 Hung Windows (H)

Double Hung, Type H-AW- 55 (Optional Performance Grade). Test and rate sash balance to conform with AAMA 902.

Design windows, mullions, hardware, and anchors to withstand the wind loading specified.

2.1.2 Glass and Glazing

Materials are specified in Section 08 81 00 GLAZING.

2.1.3 Caulking and Sealing

Are specified in Section 07 92 00 JOINT SEALANTS.

2.1.4 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 specified. Design sash for outside double glazing and for securing glass with metal beads, glazing clips, glazing channels, or glazing compound. Units must accommodate 1 inch insulated glazing composites.

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. Provide special covers over structural support at mullions as indicated.

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 stainless steel 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 organic coating.

2.2.8.1 Anodic Coating

2.2.8.2 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a high-performance finish in accordance with AAMA 2605 with total dry film thickness of not less than 1.2 mils.

Exterior color is bone white as defined in the Marine Corps Base Camp Lejeune Base Exterior Architectural Plan, Rifle Range Historic Area.

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, where indicated.

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. Adjust double hung windows to operate with maximum applied force of 25 pounds in either direction, not including breakaway friction force. 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 --

SECTION 08 71 00

DOOR HARDWARE
02/16, CHG 4: 02/22

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 A156.2 (2017) Bored and Preassembled Locks and Latches
ANSI/BHMA A156.3 (2020) Exit Devices
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
ANSI/BHMA A156.8 (2021) Door Controls - Overhead Stops and Holders
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 A156.21 (2019) Thresholds
ANSI/BHMA A156.22 (2021) Gasketing
ANSI/BHMA A156.31 (2013) Electric Strikes and Frame Mounted Actuators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

NFPA 72 (2022; ERTA 22-1) National Fire Alarm and Signaling Code

NFPA 80 (2022) Standard for Fire Doors and Other Opening Protectives

NFPA 101 (2021; TIA 21-1) Life Safety Code

NFPA 252 (2022) Standard Methods of Fire Tests of Door Assemblies

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 Bld Mat Dir (updated continuously online) Building Materials 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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Manufacturer's Detail Drawings; G

Verification of Existing Conditions; G

Hardware Schedule; G

Keying System; G

SD-03 Product Data

Hardware Items; G

SD-08 Manufacturer's Instructions

Installation

SD-10 Operation and Maintenance Data

Hardware Schedule Items, Data Package 1; G

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. 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](#)

Provide Hardware Item List and Hardware Schedule containing the following information, and additional information as needed to identify the complete make up of each hardware set and its application to each opening:

1.5.1 Hardware Item List:

- a. Hardware Type
- b. Item Number
- c. Quantity
- d. Size(s)
- e. Reference Publication / Type Number
- f. Manufacturer's Name / Catalog Number
- g. Key Control Symbols
- h. UL Mark (If fire rated and listed)
- i. BHMA Finish(es)
- j. Remarks

1.5.2 Hardware Schedule

- a. Hardware Set Number
- b. Opening Number(s)
- c. Opening Description (single/double leaf, hand, size, door/frame material)
- d. Fire Rating
- e. Sound Rating
- f. Hardware Items

- g. Quantity
- h. Size
- i. BHMA Finish
- j. Remarks

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

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.

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.

Coordinate with the Base Locksmith to resolve keying, procurement, shipping and installation procedures. Confirm keyways utilized and provide compatible cylinders and cores. Confirm hardware set components and functions.

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. Deliver permanent keys and removable cores to the Contracting Officer, either directly or by certified mail. Deliver construction master keys with the locks.

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

Hardware applied to 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 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.

2.3.1 Hinges

Provide in accordance with [ANSI/BHMA A156.1](#). Provide hinges that are [4-1/2 by 4-1/2 inch](#) unless otherwise indicated. Construct loose pin hinges for interior doors and reverse-bevel exterior doors so that pins are non-removable when door is closed. Other anti-friction bearing hinges may be provided in lieu of ball bearing hinges.

2.3.2 Locks and Latches

- a. At exterior locations provide locksets of full stainless steel type 302 or 304 construction including fronts, strike, escutcheons, [levers](#), bolts and all interior working parts. Marine Grade I, fully non-ferrous.
- b. In humid interior environments, provide interior locksets on the same Marine Grade I, fully non-ferrous as exterior locksets.

2.3.2.1 Bored Locks and Latches

Provide in accordance with [ANSI/BHMA A156.2](#), Series 4000, Grade 1.

2.3.3 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.

Use stainless steel or bronze base metal with plated finishes. Also include stainless steel fasteners and screws.

2.3.4 Cylinders and Cores

Provide cylinders and cores for new locks, including locks provided under other sections of this specification. Provide cylinders and cores with seven pin tumblers. Provide cylinders from the products of one manufacturer, and provide cores from the products of one manufacturer. Rim cylinders, mortise cylinders, and levers of bored locksets have interchangeable cores which are removable by special control keys. Stamp each interchangeable core with a key control symbol in a concealed place on the core.

Provide SFIC Series 7 pin, TB Keyway as manufactured by Best, www.bestaccess.com.

2.3.5 Electrified Hardware

Comply with the requirements of NFPA 70 for wiring of electrified hardware.

2.3.5.1 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 secure during power failure. Provide a separate power supply for electric strikes, other locking devices and ancillary parts. Provide battery backup for continued operation during power failure. Provide strikes and actuators with a minimum opening force of 2300 pounds.

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.

2.3.5.1.1 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.

2.3.5.1.2 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.

2.3.5.1.3 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.

2.3.5.1.4 Mounting Method

Provide electric strikes and actuators suitable for use with single doors,

and for right or left hand mounting as specified.

2.3.6 Keying System

Provide an extension of the existing keying system. Existing locks were manufactured by Best, www.bestaccess.com and have interchangeable cores. Provide construction interchangeable cores. Provide key cabinet as specified.

2.3.7 Lock Trim

Provide cast, forged, or heavy wrought construction and commercial plain design for lock trim.

2.3.7.1 Lever Handles

Provide lever handles. 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.

2.3.8 Keys

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 each lock of each keyed-alike group. Furnish two additional keys for each sleeping room. 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.

2.3.9 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.

2.3.10 Closers

Provide in accordance with [ANSI/BHMA A156.4](#), Series C02000, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, full metal covers and other features necessary for the particular application. Size closers in accordance with manufacturer's printed recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty.

Use stainless steel inside bracketed or door mounted closers on exterior doors. Non-ferrous closers, such as aluminum or cast bronze, are permissible where door utilization is minimal. On interior doors use closers of 302 or 304 stainless steel or non-ferrous materials. On surface-mounted closers use or apply rust inhibiting finish on all ferrous parts. Also apply this finish on concealed closers.

2.3.10.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of

manufacture, and manufacturer's size designation in locations that will be visible after installation.

2.3.11 Overhead Holders

Provide in accordance with ANSI/BHMA A156.8.

2.3.12 Door Protection Plates

Provide in accordance with ANSI/BHMA A156.6.

2.3.12.1 Sizes of Mop and Kick Plates

2 inch less than door width for single doors; 1 inch less than door width for pairs of doors. Provide 8 inch kick plates for flush doors. Provide 4 inch mop plates.

2.3.13 Door Stops and Silencers

Provide in accordance with ANSI/BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair.

2.3.14 Thresholds

Provide in accordance with ANSI/BHMA A156.21. Use J35100, with vinyl or silicone rubber insert in face of stop, for exterior doors opening out, unless specified otherwise.

2.3.15 Weatherstripping Gasketing

Provide in accordance with ANSI/BHMA A156.22. Provide the type and function designation where specified in paragraph HARDWARE SCHEDULE. Provide a set to include head and jamb seals, sweep strips, and, for pairs of doors, astragals. Air leakage of weatherstripped doors not to exceed 1.25 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283. Provide weatherstripping with one of the following:

2.3.15.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Provide clear (natural) anodized aluminum.

2.3.16 Rain Drips

Provide in accordance with ANSI/BHMA A156.22. Provide extruded aluminum rain drips, not less than 0.08 inch thick, clear anodized finish. Provide rain drips with a 2 inch overlap on each side of each exterior door that is not protected by an awning, roof, eave or other horizontal projection. Set drips in sealant and fasten with stainless steel screws.

2.3.16.1 Overhead Rain Drips

Approximately 1-1/2 inch high by 2-1/2 inch projection. Align bottom with door frame rabbet.

2.3.17 Auxiliary Hardware (Other than locks)

Provide in accordance with ANSI/BHMA A156.16, Grade 1.

2.3.18 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. Provide hinges for exterior doors in stainless steel with BHMA 630 finish. Furnish exit devices in 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 in accordance with ANSI/BHMA A156.5, E8341 (125 hooks).

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 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 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 in expansion sleeves. 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 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 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

Deliver Hardware templates and hardware, except field applied hardware, to the aluminum door and frame manufacturer for use in fabricating doors and frames.

Heavy Duty Exterior Openings

Door No. 119

HWS-3 Exterior Mechanical Pair

	6 each BB 4.5 x 4.5 Butt Hinge, NRP, A5111	630
	2 each Overhead Door Holder, C02511	626
	stop mounted slide track arm, push side mount	
Active Leaf	RHR	
	1 each Lever Storeroom, F86	630
Best	1 each 7 Pin SFIC, F24, E09241	630
	1 each Flat Overlapping Astragal	Galvanealed
Inactive Leaf	LHR	
	2 each 12" Lever Ext Flush Bolt, L14251	626
	1 each Dust Proof Strike, L04021	626
	1 each 76" Drip Ledge	MIL
	1 each 6070 Weatherstrip	MIL
	2 each 36" Bottom Sweep	MIL
	1 each 72" Threshold, J35100	MIL
	2 each Floor Stop, L02131	626

Note: Trim is to have an abrasive texture to indicate a potentially hazardous environment to the blind

Door No. 109A, 112A, 125A, 127A, 207A, 209A, 216A, 222A, 224A

HWS-4 Secure Exterior AC BEQ Entrance

	3 each BB 4.5 x 4.5 Butt Hinge, NRP, A5111	630
	1 each TS9315 SPT FMC Closer, C02231 with	630
	spring stop, stop mounted slide track arm	
	push side mount	
	1 each Lever Storeroom, F86	630
Best	1 each 7 Pin SFIC, F24, E09241	630
	1 each 40" Drip Ledge	MIL
	1 each 3070 Weatherstrip	MIL
	1 each 36" Bottom Sweep	MIL
	1 each 36" Threshold, J35100	MIL
	1 each Floor Stop, L02131	626
	1 each Power Supply	600
	1 each Electric Strike	630
GFGI	1 each Card Reader, Wall Mounted	Black

Note: Furnish electric metallic tubing raceway, cabling and a blank stainless steel coverplate to receive Government furnished and installed devices

Note: Coordinate with the Government to support GFGI devices, equipment and programming

Note: GFGI access control equipment is located in Communications 103

Heavy Duty Non Rated Openings

Door No. 120

HWS-5 Electrical > 800 Amps

	3 each BB 4.5 x 4.5 Butt Hinge, A8111	626
	1 each FMC Closer, C02241 with	630
	track hold and spring stop, stop mounted	
	slide track arm, push side mount	
	1 each Exit Device w/ Pull, EDF03	630

	entry by keyed trim, public use by dogged bar	
Best	1 each Rim Cylinder Housing, F26	630
Best	1 each 7 Pin SFIC, F24, E09241	630
	3 each Silencer, L03011	Grey
	1 each Wall Stop, L02251 or Floor Stop, L02161	626

Note: Trim is to have an abrasive texture to indicate a potentially hazardous environment to the blind

Door No. 132
HWS-6 Unisex

	3 each BB 4.5 x 4.5 Butt Hinge, A5111	630
	1 each FMC Closer, C02021	630
	1 each Lever Privacy, F76 no cylinder	630
	1 each 8 x 34 Beveled Kick Plate, J102	630
	1 each 4 x 34 Beveled Mop Plate, J103	630
	3 each Silencer, L03011	Grey
	1 each Wall Stop, L02251 or Floor Stop, L02161	626

Door No. 129, 130
HWS-7 Office

	3 each BB 4.5 x 4.5 Butt Hinge, A8111	626
	1 each Lever Entry, F109	630
Best	1 each 7 Pin SFIC, F24, E09241	630
	3 each Silencer, L03011	Grey
	1 each Wall Stop, L02251 or Floor Stop, L02161	626

Door No. 131
HWS-8 Storage

	3 each BB 4.5 x 4.5 Butt Hinge, A8111	626
	1 each Lever Storeroom, F86	630
Best	1 each 7 Pin SFIC, F24, E09241	630
	3 each Silencer, L03011	Grey
	1 each Wall Stop, L02251 or Floor Stop, L02161	626

Heavy Duty 20 Minute Rated Openings

Door No. 110, 126, 208, 223
HWS-9 Mechanical Pair, 20 Min Rating

	6 each BB 4.5 x 4.5 Butt Hinge, A8111	626
	1 each TS9315 GSR/PT FMC Door Pair Coordinator & Closer, pull side mounted	630
Active Leaf RHR	1 each Lever Storeroom, F86	630
Best	1 each 7 Pin SFIC, F24, E09241	630
Inactive Leaf LHR	1 each Constant Latching Bolt Set, Type 27	630
	1 each Dust Proof Strike, L04021	626
	2 each 8 x 34 Beveled Kick Plate, J102	630
Section 08 14 00	1 each Category A Edge Seal, UL 10C	
	1 each 6070 Category B Edge Seal, UL 10C	Charcoal
	2 each Wall Stop, L02251 or Floor Stop, L02161	626

Note: Trim is to have an abrasive texture to indicate a potentially hazardous environment to the blind

Door No. 118, 215

HWS-10 Elec/Mech/Tel Com, 20 Min Rating

	4 each BB 4.5 x 4.5 Butt Hinge, A8111	626
	1 each FMC Closer, C02021	630
	1 each Lever Storeroom, F86	630
Best	1 each 7 Pin SFIC, F24, E09241	630
Section 08 14 00	1 each Category A Edge Seal, UL 10C	
	1 each 3070 Category B Edge Seal, UL 10C	Charcoal
	1 each Wall Stop, L02251 or	626
	Floor Stop, L02161	

Note: Trim is to have an abrasive texture to indicate a potentially hazardous environment to the blind

Door No. 103, 111, 217

HWS-11 Elec/Mech/Tel Com, 20 Min Rating

	3 each BB 4.5 x 4.5 Butt Hinge, A8111	626
	1 each FMC Closer, C02021	630
	1 each Lever Storeroom, F86	630
Best	1 each 7 Pin SFIC, F24, E09241	630
Section 08 14 00	1 each Category A Edge Seal, UL 10C	
	1 each 3070 Category B Edge Seal, UL 10C	Charcoal
	1 each Wall Stop, L02251 or	626
	Floor Stop, L02161	

Note: Trim is to have an abrasive texture to indicate a potentially hazardous environment to the blind

Door No. 116, 122, 213, 219

HWS-12 Gang Head, 20 Min Rating

	3 each BB 4.5 x 4.5 Butt Hinge, A5111	630
	1 each FMC Closer, C02021	630
	1 each Lever Passage, F75	630
	no cylinder	
	1 each 8 x 34 Beveled Kick Plate, J102	630
	1 each 4 x 34 Beveled Mop Plate, J103	630
Section 08 14 00	1 each Category A Edge Seal, UL 10C	
	1 each 3070 Category B Edge Seal, UL 10C	Charcoal
	1 each Wall Stop, L02251 or	626
	Floor Stop, L02161	

Door No. 121, 218

HWS-13 Janitor, 20 Min Rating

	3 each BB 4.5 x 4.5 Butt Hinge, A5111	630
	1 each FMC Closer, C02021	630
	1 each Lever Storeroom, F86	630
Best	1 each 7 Pin SFIC, F24, E09241	630
	1 each 8 x 34 Beveled Kick Plate, J102	630
	1 each 4 x 34 Beveled Mop Plate, J103	630
Section 08 14 00	1 each Category A Edge Seal, UL 10C	
	1 each 3070 Category B Edge Seal, UL 10C	Charcoal
	1 each Wall Stop, L02251 or	626
	Floor Stop, L02161	

Note: Trim is to have an abrasive texture to indicate a potentially hazardous environment to the blind

Door No. 104A, 104B, 203A, 203B

HWS-14 Office, 20 Min Rating

	3 each BB 4.5 x 4.5 Butt Hinge, A8112	626
	1 each FMC Closer, C02021	630

	1 each Lever Entry, F109	630
Best	1 each 7 Pin SFIC, F24, E09241	630
Section 08 14 00	1 each Category A Edge Seal, UL 10C	
	1 each 3070 Category B Edge Seal, UL 10C	Charcoal
	1 each Wall Stop, L02251 or Floor Stop, L02161	626
Door No. 101, 106, 108, 202, 205		
HWS-15 Storage, 20 Min Rating		
	3 each BB 4.5 x 4.5 Butt Hinge, A8112	626
	1 each FMC Closer, C02021	630
	1 each Lever Storeroom, F86	630
Best	1 each 7 Pin SFIC, F24, E09241	630
Section 08 14 00	1 each Category A Edge Seal, UL 10C	
	1 each 3070 Category B Edge Seal, UL 10C	Charcoal
	1 each Wall Stop, L02251 or Floor Stop, L02161	626

Heavy Duty 45 Minute Rated Openings

Door No. 114, 211		
HWS-16 Laundry, 45 Min Rating		
	3 each BB 4.5 x 4.5 Butt Hinge, A5111	630
	1 each FMC Closer, C02021	630
	1 each Lever Classroom, F84	630
Best	1 each 7 Pin SFIC, F24, E09241	630
	1 each 8 x 34 Beveled Kick Plate, J102	630
	1 each 3070 Weatherstrip	MIL
	1 each Wall Stop, L02251 or Floor Stop, L02161	626

Note: Trim is to have an abrasive texture to indicate a potentially hazardous environment to the blind

Heavy Duty 1 Hour Rated Openings

Door No. 102B, 107B, 201, 206		
HWS-17 Stair, 1 Hour Rating		
	3 each BB 4.5 x 4.5 Butt Hinge, A8111	626
	1 each FMC Closer, C02021	630
	1 each Lever Passage, F75 no cylinder	630
	1 each 8 x 34 Beveled Kick Plate, J102	630
Section 08 14 00	1 each Category A Edge Seal, UL 10C	
	1 each 3070 Category B Edge Seal, UL 10C	Charcoal
	1 each Wall Stop, L02251 or Floor Stop, L02161	626

-- End of Section --

SECTION 08 81 00

GLAZING
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.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 800 (2016) Voluntary Specifications and Test Methods for Sealants

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 C509 (2006; R 2021) Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material

ASTM C920 (2018) Standard Specification for Elastomeric Joint Sealants

ASTM C1021 (2008; R 2014) Standard Practice for Laboratories Engaged in Testing of Building Sealants

ASTM C1036 (2021) Standard Specification for Flat Glass

ASTM C1048 (2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass

ASTM C1087 (2016) Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems

ASTM C1281 (2016) Standard Specification for Preformed Tape Sealants for Glazing Applications

ASTM D395 (2016; E 2017) Standard Test Methods for Rubber Property - Compression Set

ASTM D2287 (2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds

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-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

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval 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

Insulating Glass

Glazing Accessories

Sealants

Joint Backer

SD-04 Samples

Insulating Glass

Glazing Tape

Sealing Tapes

SD-08 Manufacturer's Instructions

Setting and Sealing Materials

Glass Setting

SD-11 Closeout Submittals

Warranty for Insulated Glass Units

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 QUALITY CONTROL

Submit two [8 by 10 inch](#) samples of each of the following: tinted glass and insulating glass units.

1.5 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.

1.6 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.

1.7 WARRANTY

1.7.1 Warranty for Insulated 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 PRODUCT SUSTAINABILITY CRITERIA

2.2 GLASS

[ASTM C1036](#), unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to [16 CFR 1201](#).

2.2.1 Clear Glass

For interior glazing (i.e., pass and observation windows), [1/4 inch](#) thick

tempered glass should be used.

2.2.2 Tempered Glass

ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class 2 (tinted heat absorbing), Quality q3, 0.25 inch thick, 0.25 percent shading coefficient conforming to ASTM C1048 and GANA Standards Manual. Color must be clear or gray as selected.. .

2.3 INSULATING GLASS UNITS

Glazing for exterior windows is a 1 inch insulated glass composite consisting of an exterior layer of 0.25 inch thick, clear, tempered glass; 0.5 inch air space; and an interior layer of 0.25 inch thick, tinted, laminated annealed float glass with a 0.25 SHGC and U-value of 0.30 or better. Laminated float glass is an 0.125 inch thick glass with 0.030 inch vinyl interlayer and 0.125 inch thick glass with Solar E coating on Surface 3. Tinting requires heat strengthened glass complying with ASTM C1048.

Colored, aluminum window shadow bars are positioned within the air space. Ensure that clear glazing is positioned in front of shadow bars and on the outside composite face. Tinted glazing is layered behind shadow bars and on the inside composite face.

2.4 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. Sealant testing must be performed by a testing agency qualified according to ASTM C1021.

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified.

2.4.1 Sealants

Provide elastomeric sealants.

2.4.1.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing metal sash. Sealants must be chemically compatible with setting blocks, edge blocks, and sealing tapes, with sealants used in manufacture of insulating glass units. Color of sealant must be white.

2.4.2 Joint Backer

Joint backer must have a diameter size at least 25 percent larger than joint width; type and material as recommended in writing by glass and sealant manufacturer.

2.4.3 Glazing Tapes

2.4.3.1 Back-Bedding Mastic Glazing Tapes

Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for

application indicated; and complying with [ASTM C1281](#) and [AAMA 800](#) for products indicated below:

- a. AAMA 804.3 tape, where indicated.
- b. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
- c. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.4.4 Sealing Tapes

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.

2.4.5 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.

2.4.6 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. Use [ASTM C1087](#) to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to surface.

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 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. 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.

3.3 CLEANING

Clean glass surfaces and remove labels, paint spots, 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. Remove and replace glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities with new units.

-- End of Section --

SECTION 08 91 00

METAL 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

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 2605 (2020) Voluntary Specification,
Performance Requirements and Test
Procedures for Superior Performing Organic
Coatings on Aluminum Extrusions and Panels

ASTM INTERNATIONAL (ASTM)

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wall Louvers

SD-03 Product Data

Metal Wall Louvers

SD-04 Samples

Wall Louver Samples; G

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 must closely approximate colors indicated.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Aluminum Sheet

ASTM B209, alloy 3003 or 5005 with temper as required for forming.

2.1.2 Extruded Aluminum

ASTM B221, alloy 6063-T5 or -T52.

2.2 METAL WALL LOUVERS

Wind driven rain resistant type, with bird screens and made to withstand a wind load of not less than 54 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. Louvers must meet wind driven rain resistance standards of the Miami-Dade County Code and have a Miami-Dade County Notice of Acceptance.

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 Mullions and Mullion Covers

Same material and finish as louvers. Provide mullions where indicated. Furnish concealed mullions at 5 feet on center for larger fabrications. Provide mullion covers on both faces of joints between louvers.

2.2.3 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. 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.
Provide other accessories as required for complete and proper installation.

2.4 FINISHES

2.4.1 Aluminum

Exposed aluminum surfaces must be factory finished with an organic coating.
Louver is bone white as indicated in the Marine Corps Base Camp Lejeune, Base Exterior Architectural Plan, Rifle Range Historic Area.

2.4.1.1 Anodic Coating

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45 and AAMA 611. Finish must be:

2.4.1.2 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a superior performance finish in accordance with AAMA 2605 with total dry film thickness of not less than 1.2 mil.

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 Screens and Frames

Attach frames to louvers with screws or bolts.

3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS

3.2.1 Aluminum

Where aluminum contacts metal other than zinc, paint the dissimilar metal with a primer and two coats of aluminum paint.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 09 22 00

SUPPORTS FOR PLASTER AND GYPSUM BOARD
02/10, CHG 2: 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 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
ASTM C841	(2003; R 2013) Installation of Interior Lathing and Furring
ASTM C847	(2014a) Standard Specification for Metal Lath

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM EMLA 920	(2009) Guide Specifications for Metal Lathing and Furring
----------------	---

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 Contractor Quality Control approval 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

Metal Support Systems

Recycled Content for Metal Support Systems; S

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 Lath

2.1.1.1 Suspended Ceiling Systems and Wall Furring

ASTM C841, and ASTM C847.

2.1.1.2 Non-load Bearing Wall Framing

NAAMM EMLA 920.

2.1.2 Materials for Attachment of Gypsum Wallboard

2.1.2.1 Suspended Ceiling Systems

ASTM C645.

2.1.2.2 Non-load Bearing Wall Framing and Furring

ASTM C645, but not thinner than 0.0179 inch thickness.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Systems for Attachment of Gypsum Wallboard

3.1.1.1 Suspended Ceiling Systems

ASTM C754, except provide framing members 16 inches o.c. unless indicated otherwise.

3.1.1.2 Non-load Bearing Wall Framing and Furring

ASTM C754, except as indicated otherwise.

3.2 ERECTION TOLERANCES

Provide framing members which will be covered by finish materials such as wallboard 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 09 29 00

GYPSUM BOARD

08/16, CHG 4: 02/20

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 NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.11 (1992; Reaffirmed 2005) Specifications for Interior Installation of Cementitious Backer Units

ASTM INTERNATIONAL (ASTM)

ASTM C475/C475M (2017; R 2022) 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 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 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 D1037 (2012) Evaluating Properties of Wood-Base Fiber and Particle Panel Materials

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 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 E84 (2020) Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM E695 (2003; R 2015; E 2015) Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading

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/>

GYPSUM ASSOCIATION (GA)

GA 214 (2010) Recommended Levels of Gypsum Board Finish

GA 216 (2010) Application and Finishing of Gypsum Panel Products

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

UL Fire Resistance (2014) Fire Resistance 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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Cementitious Backer Units

Abuse Resistant Gypsum Board

Accessories

Submit for each type of gypsum board and for cementitious backer units.

Gypsum Board

Recycled Content for Gypsum Board; S

Recycled Content for Paper Facing and Gypsum Cores; S

VOC Content of Joint Compound; S

SD-07 Certificates

Asbestos Free Materials; G

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; S

SD-08 Manufacturer's Instructions

Safety Data Sheets

SD-10 Operation and Maintenance Data

Manufacturer Maintenance Instructions

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.

1.4 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 gypsum wallboard with materials which have high emissions of volatile organic compounds (VOCs) or other contaminants. 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 SCHEDULING

The gypsum wallboard must be taped, finished and primed before the installation of the highly-emitting materials.

Commence application only after the area scheduled for gypsum board work is completely weathertight. The heating, ventilating, and air-conditioning systems must be complete and in operation prior to application of the gypsum board. If the mechanical system cannot be activated before gypsum board is begun, the gypsum board work may proceed in accordance with an approved plan to maintain the environmental conditions specified below. Apply gypsum board prior to the installation of finish flooring and acoustic ceiling.

1.7 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.

1.8 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, cementitious backing units and joint treating materials manufactured from [asbestos free materials](#) only. [Submit Safety Data Sheets and manufacturer maintenance instructions for gypsum materials including adhesives.](#)

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. [Provide moisture resistant gypsum board in toilet rooms.](#)

2.1.2 Abuse Resistant Gypsum Board

[Provide abuse resistant gypsum board in the Squad Bays and corridors.](#)

[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 75 or less and a smoke developed rating of 100 or less.

2.1.2.1 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.

2.1.2.2 Hard Body Impact Test

Comply with hard body impact test in accordance with ASTM C1629/C1629M Classification Level 2.

2.1.2.3 Surface Abrasion Test

Comply with test surface abrasion test in accordance with ASTM C1629/C1629M.

2.1.2.4 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.

2.1.3 Cementitious Backer Units

In accordance with the Tile Council of America (TCA) Handbook.

2.1.4 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.

2.1.4.1 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

2.1.4.2 Joint Tape

Use cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape recommended by the manufacturer.

2.1.5 Fasteners

2.1.5.1 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.

2.1.6 Accessories

ASTM C1047. Fabricate from corrosion protected steel 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.

2.1.7 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. 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 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with [ASTM C840](#), System XIII or [GA 216](#).

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 above ceilings to Level 1 in accordance with GA 214. Unless otherwise specified, finish all gypsum board 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.

3.6 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. 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.

-- End of Section --

SECTION 09 30 10

CERAMIC TILING
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 NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.02	(2016) General Requirements: Materials, Environmental, and Workmanship.
ANSI A108.5	Installation of ceramic tile with dry-set portland cement mortar or latex -portland cement mortar
ANSI A108.10	Installation of grout in tilework
ANSI A118.3	American national standard specifications for chemical resistant, water cleanable tile-setting and grouting epoxy and water cleanable tile-setting epoxy adhesive
ANSI A118.4	American national standard specifications for chemical resistant, water cleanable tile-setting and grout epoxy and water cleanable tile-setting epoxy adhesive
ANSI A118.10	American national standard specifications for load bearing, bonded, waterproof membranes for thin-set ceramic tile and dimension stone installation
ANSI A136.1	(2008) 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 C1027	(2009; R 2017) Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
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

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 Contractor Quality Control
approval. Submit the following in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

SD-03 Product Data

Porcelain Tile; G

Recycled Content for Porcelain Tile

Setting-Bed; G

Mortar, Grout, and Adhesive; GSD-04 Samples

Tile; G

Accessories; G

Transition Strips; G

Grout; G

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; G

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 requirements 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 must be provided from a single source. Each type and color of mortar, adhesive, and grout must 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 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 400 lbf. for porcelain wall tile and 350 lbf. for floor tile in accordance with ASTM C648. Provide floor tiles with a wet dynamic coefficient of friction (DCOF) value of 0.5 or greater when tested in accordance with ANSI A137.1 requirements. Provide glazed floor tile with a Class IV-Commercial or V-Heavy 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 unglazed or glazed, rectified porcelain tile, and trim pieces as indicated on the drawings with color extending uniformly through the body of the tile. Provide tile with a V1 or V2 aesthetic classification. Blend tiles in factory and in a packages to have same color range and continuous blend for installation. Provide nominal tile size(s) as indicated on the drawings. Provide a 0.50 percent maximum water absorption in accordance with ASTM C373.

Provide field Porcelain Tiling Materials that contain a minimum of 4 percent recycled content. Provide accent porcelain tiling with a minimum of 20 percent recycled content. Provide data identifying percentage of recycled content for porcelain tile.

2.2 SETTING-BED

Submit manufacturer's catalog data. Compose the setting-bed of the following materials:

2.2.1 Portland Cement

Conform to ASTM C150/C150M for cement, Type I, white for wall mortar and

gray for other uses.

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](#). [Submit two color samples of grout for approval.](#)

2.4.1 Latex-Portland Cement Mortar

[Must comply with ANSI A118.4.](#)

2.4.2 Organic Adhesive

Type I. Water-resistant. Comply with [ANSI A136.1](#).

2.4.3 Epoxy Resin Grout

[TCNA Hdbk](#). [Provide product with GreenGuard Certification. Product must be stainproof and uniform in color. It must meet performance requirements of ANSI A118.3.](#)

2.4.4 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 TRANSITION STRIPS

Provide clear anodized aluminum transitions between tile and carpet or resilient flooring. Provide types as recommended by flooring manufacturer for both edges and transitions of flooring materials. Provide transition strips that comply with [36 CFR 1191](#) requirements.

2.6 COLOR, TEXTURE, AND PATTERN

Provide color, pattern and texture in accordance with as indicated [on drawings](#). Color listed is not intended to limit the selection of equal colors from other manufacturers. Provide floor patterns as specified on the drawings.

PART 3 EXECUTION

3.1 PREPARATORY WORK AND WORKMANSHIP

Inspect surface to receive tile in conformance to the requirements of [ANSI A108.02 standards](#) 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 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 drawings](#) at 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 W244-19](#) in areas with [cementitious backer units](#), [W248-19](#) in areas with [glass mat water-resistant gypsum tile backing board](#). Grout joints must be installed as recommended by the manufacturer for the type of tile and as indicated on drawings. Install thinner wall tile flush with thicker wall tile applied on same wall and provide installation materials as recommended by the tile and

setting materials manufacturer's to achieve flush installation. Align grout joints of wall and floor tile if possible. Provide crack isolation membrane at all first floor locations that specify a latex portland cement mortar - ANSI A118.4 or better or ISO C2S1 or better. Provide a water proof membrane at all above ground applications - ANSI A118.10. Conform to TCNA Hdbk TR711-19 for tiling over other surfacing/materials in renovation conditions. Tile walls in accordance with ANSI A108.4.

3.3.1 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.

3.3.2 Organic Adhesive

Conform to TCNA Hdbk W242-19 for the organic adhesive installation of ceramic tile.

3.3.3 Epoxy Tile Grout

Prepare and install epoxy 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 INSTALLATION OF FLOOR TILE

Install floor tile in accordance with TCNA Hdbk F114-19 method and with grout joints as recommended by the manufacturer for the type of tile or as indicated on drawings. Provide crack isolation membrane at all first floor locations that specify a latex portland cement mortar - ANSI A118.4 or better or ISO C2S1 or better. Provide a water proof membrane at all above ground applications - ANSI A118.10. Conform to TCNA Hdbk TR711-19 for tiling over other surfacing/materials in renovation conditions. Tile flooring in accordance with ANSI A108.4.

3.4.1 Latex-Portland Cement

Use Latex-Portland cement mortar to install tile directly over properly cured, plane, clean concrete slabs in accordance with ANSI A108.5. Use Latex Portland cement when installing porcelain ceramic tile.

3.4.2 Epoxy Tile Grout

Prepare and install epoxy tile grout in accordance with ANSI A108.10. Provide and apply manufacturer's standard product for sealing grout joints in accordance with manufacturer's recommendations.

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.

3.6 EXPANSION JOINTS

Reference and follow TCNA EJ171-19. Form and seal joints as specified in Section 07 92 00 JOINT SEALANTS.

3.6.1 Walls

Provide expansion joints at control joints in backing material. Wherever backing material changes, install an expansion joint to separate the different materials.

3.6.2 Floors

Provide expansion joints over construction joints, control joints, and expansion joints in concrete slabs.

3.7 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 must be continuously used as passageways by workmen. Replace damaged or defective tiles. Submit copy of manufacturer's printed [maintenance instructions](#).

-- End of Section --

SECTION 09 51 00

ACOUSTICAL CEILINGS

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 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 C423	(2009a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C635/C635M	(2022) 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	(2022) 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 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

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168 (2017) Adhesive and Sealant Applications

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. Submit the following in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G

SD-03 Product Data

Acoustical Ceiling Systems; G

Recycled Content For Type III Ceiling Tiles

SD-04 Samples

Acoustical Units; G

Acoustical Ceiling Tiles; G

SD-06 Test Reports

Ceiling Attenuation Class and Test (ACT-1); G

Ceiling Attenuation Class and Test (ACT-2)

SD-07 Certificates

Indoor Air Quality for Type VII Ceiling Tiles; S

Indoor Air Quality for Sealants

Indoor Air Quality For Type III Ceiling Tiles

1.3 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.

1.4 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.

1.5 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.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period. Include an agreement to repair or replace acoustical panels that fail within the warranty period in the standard performance guarantee or warranty. Failures include, but are not limited to, sagging and warping of panels; rusting and manufacturers defects of grid system.

1.7 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.

1.8 OTHER SUBMITTAL REQUIREMENTS

Submit the following:

- a. Manufacturer's catalog showing UL classification of fire-rated ceilings giving materials, construction details, types of floor and roof constructions **must be** protected, and UL design number and fire protection time rating for each required floor or roof construction and acoustic ceiling assembly.
- b. Reports by an independent testing laboratory attesting that **acoustical ceiling systems** meet specified sound transmission requirements. Data attesting to conformance of the **specified** system to Underwriters Laboratories requirements for the fire endurance rating listed in UL Fire Resistance may be submitted in lieu of test reports.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide sound controlling units mechanically mounted on a ceiling

suspension system for acoustical treatment. The unit size, texture, finish, and color must be as specified. The location and extent of acoustical treatment must be 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 [must](#) be removed from the job site.

2.1.1 Ceiling Attenuation Class and Test (ACT-1)

Provide a ceiling system with an attenuation class (CAC) of 35 for ACT-1 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 [Enter Appropriate Subpart Title Here]Ceiling Attenuation Class and Test (ACT-2)

Provide a ceiling system with a superior sag/humidity and mold resistance. Provide a ceiling system with an attenuation class (CAC) of 33 [ASTM E1414/E1414M](#). Product must be made of mineral fiber and should have a textured surface (White). 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.

2.2.1 Ceiling Sound Absorption

Determine the Noise Reduction Coefficient (NRC) in accordance with [ASTM C423](#) Test Method

2.3 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:

2.3.1 Units for Exposed-Grid System ACG-1

2.3.1.1 Type

III (non-asbestos mineral fiber with painted finish). Provide Type III [Acoustical Ceiling Tiles](#) containing a minimum of 67 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.

2.3.1.2 Flame Spread

Class A, 25 or less

2.3.1.3 Pattern

Pattern E

2.3.1.4 Minimum NRC

0.75 in all rooms and areas when tested on mounting Type E-400 of
ASTM E795.

2.3.1.5 Minimum Light Reflectance Coefficient

0.85 or greater

2.3.1.6 Nominal Size

24 by 24 inch

2.3.1.7 Edge Detail

Square

2.3.1.8 Finish

Factory-applied standard finish.

2.3.1.9 Minimum CAC

35

2.3.2 Units for Exposed-Grid System ACG-2

2.3.2.1 Type

III (non-asbestos mineral fiber with painted finish). Provide Type III
Acoustical Ceiling Tiles containing a minimum of 36 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.

2.3.2.2 Flame Spread

Class A, 25 or less

2.3.2.3 Pattern

E

2.3.2.4 Minimum NRC

0.50 when tested on mounting Type B or Type E-400 of ASTM E795

2.3.2.5 Minimum Light Reflectance Coefficient

LR-1, 0.89 or greater

2.3.2.6 Nominal Size

24 by 24 inch

2.3.2.7 Edge Detail

Square

2.3.2.8 Finish

Factory-applied white color finish

2.3.2.9 Minimum CAC

33

2.3.3 Metal Faced Composition Units (ACG-2)

2.3.3.1 Type VII (Aluminum facings with non-asbestos mineral composition absorbent backing) with baked polyester paint. Provide certification of indoor air quality for Type VII Ceiling Tiles.

2.3.4 Unit Acoustical Absorbers

Absorbers must be individually mounted sound absorbing plaques composed of glass fibers or non-asbestos mineral fibers and having a NRC range of not less than 0.60 - 0.70 when tested in accordance with ASTM C423 and reported as a 4 frequency average.

2.4 SUSPENSION SYSTEM

Provide standard exposed-grid suspension system as shown on drawings conforming to ASTM C635/C635M for intermediate-duty systems. Provide surfaces exposed to view of galvanized steel with a factory-applied baked polyester white paint finish. Provide finish color as shown on drawings. Provide wall molding having a flange of not less than 15/16 inch. Provide inside and outside corner caps standard mitered corners. Suspended ceiling framing system must have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown. Provide a suspension system with a maximum deflection of 1/360 of the span length.

2.5 HANGERS

Provide hangers and attachment capable of supporting a minimum 300 pound ultimate vertical load without failure of supporting material or attachment.

2.5.1 Wires

Conform wires to ASTM A641/A641M, Class 1, 0.08 inch (12 gauge) in diameter.

2.5.2 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.

2.5.3 Rods

Provide 3/16 inch diameter threaded steel rods, zinc or cadmium coated.

2.5.4 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, zinc coated.

2.5.5 Anchorage Devices

Comply with ASTM C636/C636M for anchorage devices for eyebolts. 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.

2.6 ACCESS PANELS

Provide access panels that match adjacent acoustical units, designed and equipped with suitable framing and fastenings for removal and replacement without damage. Size panel must be not less than 12 by 12 inch or more than 12 by 24 inch.

- a. Attach an identification plate of 0.032 inch thick aluminum, 3/4 inch in diameter, stamped with the letters "AP" and finished the same as the unit, near one corner on the face of each access panel.
- b. Identify ceiling access panel by a number utilizing white identification plates or plastic buttons with contrasting numerals. Provide plates or buttons of minimum 1 inch diameter and securely attached to one corner of each access unit. Provide a typewritten card framed under glass listing the code identification numbers and corresponding system descriptions listed above. Mount the framed card where directed and furnish a duplicate card to the Contracting Officer. Code identification system is as follows:

- 1 Fire detection/alarm system
- 2 Air conditioning controls
- 3 Plumbing system
- 4 Heating and steam systems
- 5 Air conditioning duct system
- 6 Sprinkler system
- 7 Telephone junction boxes

2.7 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.

2.8 COLORS AND PATTERNS

Use colors and patterns for acoustical units and suspension system components [as specified in the drawings](#).

2.9 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 classroom 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.

3.2 CEILING ACCESS PANELS

Locate ceiling access panels directly under the items which require access.

3.3 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 units as directed.

3.4 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

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 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	(2022) 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
ASTM F710	(2021) Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring

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 SUBMITTALS

Government approval is required for all submittals. 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

Wall Base

SD-04 Samples

Resilient Flooring and Accessories; G

SD-06 Test Reports

Moisture, Alkalinity and Bond Tests; G

SD-07 Certificates

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 FLOORSORE, [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 free from strong contaminant sources and residues with ambient air temperature maintained above 65 degrees F and below 85 degrees F, stacked according to manufacturer's recommendations. Remove resilient flooring products from packaging to allow ventilation prior to installation. 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 rubber surface products with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store exposed rubber surface materials in occupied spaces.

1.5 ENVIRONMENTAL REQUIREMENTS

Maintain areas to receive resilient product at a temperature above 65 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 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, TP (thermoplastic rubber), Style A (straight - installed with carpet), and straight wall base with rubber quarterround installed with resilient flooring. Provide 8 inch high and a minimum 1/8 inch thick wall base with single straight notched profile. See architectural drawings for details. Provide 1/2 inch rubber quarterround

at the base of the 8 inch high wall base on all resilient flooring. Quarterround to have the same color finish as 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 rubber 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 base and accessories that are required by the manufacturer and comply with local indoor air quality standards. Provide adhesives for base and accessories that are required by the base manufacturer. Submit manufacturer's descriptive data, documentation stating physical characteristics, and mildew and germicidal characteristics.

Provide certification or validation of indoor air quality for adhesives.

2.4 SURFACE PREPARATION MATERIALS

Provide surface preparation materials, such as floor crack fillers as required by the flooring manufacturer for the subfloor conditions. Comply with ASTM F1482 for panel type underlayment products under a concrete substrate.

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 flooring and accessories as indicated on the drawings. Color listed is not intended to limit the selection of equal colors from other manufacturers. Provide floor patterns as specified on the on the drawings. 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 scaled drawings indicating patterns (including location of patterns and colors) and dimensions. 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 0.22 or 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 [must](#) 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 WALL BASE](#)

[Install wall base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with](#)

manufacturer's printed directions. Tighten base joints and make even with adjacent resilient flooring. Fill voids along the top edge of base at masonry walls with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners.

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 --

SECTION 09 67 23.13

STANDARD RESINOUS FLOORING

11/19

PART 1 GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

1.1.1 Pre-Installation Meetings

Pre-installation Conference: Conduct conference at Project site.

1.1.2 Product Data

Within 30 days of contract award, submit [manufacturer's catalog data](#) for the following items:

- a. [Urethane Mortar](#)
- b. [Quartz Aggregate](#)
- c. [Epoxy grout coat](#)
- d. [Urethane Sealer](#)

1.1.3 Design Mix Data

Within 30 days of contract award, submit [design mix data](#) for the following items, including a complete list of ingredients and admixtures:

- a. [Urethane Mortar](#)
- b. [Epoxy grout coat](#)
- c. [Urethane Sealer](#)

Ensure applicable test reports verify the mix has been successfully tested and meets design requirements.

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 Contractor Quality Control approval. Submit the following in accordance with Section [01 33 00](#) SUBMITTAL PROCEDURES:

[SD-02 Shop Drawings](#)

[Installation Drawings; G](#)

[Fabrication Drawings; G](#)

[SD-03 Product Data](#)

[Manufacturer's Catalog Data; G](#)

[SD-04 Samples](#)

Hardboard Mounted Epoxy Flooring; G

SD-05 Design Data

Design Mix Data; G

SD-07 Certificates

Listing of Product Installations

Referenced Standards Certificates

SD-11 Closeout Submittals

Warranty; G

1.3 DELIVERY, STORAGE, AND HANDLING

Protect materials from weather, soil, and damage during delivery, storage, and construction. Deliver materials in original packages, containers, or bundles bearing brand name and name of material.

Maintain materials used in the installation of floor topping at a temperature between 65 and 85 degrees F.

1.4 QUALITY CONTROL

Prior to commencement of work, submit [referenced standards certificates](#) for the following, showing conformance with the referenced standards contained in this section:

The ROICC reserves the right to randomly core the floor for thickness verification. The correction of any deficiencies are the responsibility of the Contractor. Areas found to be in compliance shall be repaired at the expense of the Government.

1.4.1 Qualifications

Submit a [listing of product installations](#) for heavy duty epoxy flooring including identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Identify purchaser, address of installation, service organization, and date of installation.

Ensure floor system applicators are experienced in the application of troweled [urethane quartz](#) aggregate thin-set floor topping.

1.4.2 Sampling

Submit [hardboard mounted epoxy flooring](#) samples not less than 5 inch square for each required color.

Provide panels showing nominal thickness of finished toppings, color, and texture of finished surfaces. Finished floor toppings and the approved samples are to match in color and texture.

1.5 WARRANTY

Submit a 2 year written [warranty](#) for all materials and installation work.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit [installation drawings](#) for heavy duty epoxy flooring systems clearly designating the areas of application and the installation plan. Include in the installation plan, methods to control sand and dust if sand blasting is required.

Submit [fabrication drawings](#) for heavy duty epoxy flooring Systems consisting of fabrication and assembly details to be performed in the factory.

2.2 RESINOUS FLOORING

Resinous flooring spec shall be a nominal 1/4" thick system comprised of a high performance, two-component, solvent free, general service epoxy coating. Epoxy coating is abrasion, corrosion and chemically resistant and hardens to a high-gloss finish.

2.2.1 Physical Properties

Provide flooring system in which physical properties of topping including aggregate, when tested in accordance with standards or procedures referenced below, are as follows:

1. Tensile Strength: 1,600 psi per ASTM C307
2. Flexural Strength: 4,000 psi per ASTM C580
3. Flexural Modulus of Elasticity: 1.0×10^6 psi per ASTM C580
4. Hardness: 85 to 90 per ASTM D2240, Shore D
5. Impact Resistance: > 160 in./lbs. per ASTM D2794
6. Abrasion Resistance: 0.06 gm max. weight loss per ASTM D 4060, CS-17
7. Flammability: Class 1 per ASTM E-648.
8. Thermal Coefficient of Linear Expansion: 1.4×10^{-5} in./in. o

PART 3 EXECUTION

3.1 PREPARATION

Prior to applying resinous flooring material, inspect substrate and immediately report any unsatisfactory conditions that exist and repair.

3.1.1 Safety Precautions

Prior to application in confined spaces of toppings and coatings containing flammable or toxic properties, institute safety precautions recommended by the manufacturer of the product.

Erect "NO SMOKING" signs, and prohibit smoking or use of spark- or flame-producing devices within [50 feet](#) of any mixing or placing operation involving flammable materials.

Provide the personnel required to handle, mix, or apply toppings

containing toxic or flammable properties with such items of personal protective equipment and apparel for eye, skin, and respiratory protection as are recommended by the manufacturer of the product. Ensure all personnel are trained in the appropriate use and wearing of personal protection equipment.

3.1.2 Protection of Adjacent Surfaces

In addition to the protection of adjacent surfaces during installation, provide areas used to store and mix materials with a protective covering under the materials. After application of the sealer coats, protect finished flooring during the remainder of the construction period. In areas of expected minimum or moderate traffic, cover floors with 70 pound kraft paper, a 30-30-30 waterproof kraft paper or an approved substitute, with strips taped together and edges secured to prevent roll-up. Place vegetable fiberboard, plywood, or other suitable material that does not mar the flooring over the paper to protect areas used as passages by workmen and areas subject to floor damage because of subsequent building operations. Upon completion of construction, remove the protection, clean flooring and, where necessary, repair, reseal, or both, at no additional cost to the Government.

3.1.3 Concrete Subfloor

3.1.3.1 Existing Concrete Floors

Concrete preparation must be by mechanical means and include use of a scabblers, scarifier or shot blast machine for removal of bond inhibiting materials such as curing compounds or laitance. Fill all cracks with an elastomeric jointing compound compatible with the resinous flooring system used.

3.2 APPLICATION

3.2.1 Areas of Application

Anchor plates set with the top surface at or above the finished epoxy floor level do not require coverage with this flooring material. Extend flooring under equipment, except when the equipment base is indicated to be flush against the structural floor. Cover and/or mask surfaces not to receive the epoxy floor topping, such as equipment or cabinets installed prior to surface-preparation efforts and adjacent to the flooring installation.

3.2.2 Application of Prime Coat and Troweling

General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.

2. Cure resinous flooring components according to manufacturer's written instructions.

Prevent contamination during application and curing processes.

3. At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.

- a. Apply joint sealant to comply with manufacturer's written recommendations.

b. Apply primer where required by resinous system, over prepared substrate at manufacturer's recommended spreading rate.

c. Integral Cove Base: Stonshield cove mortar, apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, of cove base. Round internal and external corners.

d. Apply primer where required by resinous system, over prepared substrate at manufacturer's recommended spreading rate.

e. Broadcast: Immediately broadcast quartz silica aggregate into the primer using manufacturer's specially designed spray caster. Strict adherence to manufacturer's installation procedures and coverage rates is imperative.

f. Undercoat: Remove any surface irregularities by lightly abrading and vacuuming the floor surface. Mix and apply undercoat with strict adherence to manufacturer's installation procedures and coverage rates.

g. Broadcast: Immediately broadcast quartz silica aggregate into the undercoat using manufacturer's specially designed spray caster. Strict adherence to manufacturer's installation procedures and coverage rates is imperative.

h. Apply topcoat(s) in number of coats indicated for flooring system and at spreading rates recommended in writing by manufacturer.

Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 24 hours.

After mixing, epoxy has a cure rate @ 77 degrees farenheight: 12 hours foot traffic, 24 hours normal operations.

Place the floor topping prior to final gelling of the prime/scratch coat. Immediately after the materials are mixed as specified, dump the mixture in the placement area and spread to prolong troweling life. Screed or rough trowel placed materials to the specified thickness and then compact by the use of a smooth roller prior to finish troweling to a nominal thickness of $\frac{3}{16}$ inch plus or minus $\frac{1}{16}$ inch. Ensure all finished surfaces are free of ridges, hollows (bird-baths), trowel marks, and smoothness varies no more than $\frac{1}{8}$ inch when tested with an 8 foot straightedge. Make provisions to maintain the work areas in a relatively dust-free environment during curing of the topping. Epoxy flooring should be applied at ambient temperatures of 60 to 85°F and humidity below 80%. Flooring is applied with a rubber squeegee and medium nap roller. The roller is used to remove squeegee lines and smooth out the surface. A brush may be used where necessary. Epoxy flooring may be applied at variable thicknesses ranging from 4 to 6 mil minimum dry film thickness. Each additional coat may be applied when the surface is tack-free, which is about 8 hours. Any questions regarding the application of the expoxy flooring must be directed to the manufacturer's Technical Service Department.

3.3 FIELD QUALITY CONTROL

3.3.1 Repairing

Remove and replace damaged or unacceptable portions of completed work with new work to match adjacent surfaces at no additional cost to the

Government.

3.4 ADJUSTING AND CLEANING

Clean surfaces of the new work, and adjacent surfaces soiled as a result of the work. Remove all equipment, surplus materials, and rubbish associated with the work from the site.

-- End of Section --

SECTION 09 68 00

CARPETING

11/17, 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.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

- | | |
|-----------|---|
| AATCC 16 | (2004; E 2008; E 2010) Colorfastness to Light |
| AATCC 134 | (2016) Electrostatic Propensity of Carpets |
| AATCC 174 | (2016) Antimicrobial Activity Assessment of New Carpets |

ASTM INTERNATIONAL (ASTM)

- | | |
|------------|---|
| 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 D3676 | (2013) Rubber Cellular Cushion Used for Carpet or Rug Underlay |
| 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 Commercial 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

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

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Carpet; G

Carpet Cushion; G

Recycled Content for Carpeting

Recycled Content for Polyurethane-Foam Cushion;

Moldings; G

Indoor Air Quality for Aerosol Adhesives

Indoor Air Quality for Non-Aerosol Adhesives

Indoor Air Quality for Concrete Primer

SD-04 Samples

Carpet; G

Moldings; G

Carpet Cushion; G

SD-06 Test Reports

Moisture and Alkalinity Tests; G

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 protected from damage, soiling, and moisture, and maintain at a temperature above **60 degrees F** for 2 days prior to installation. 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 **Tile**: Two "Production Quality" samples **24 by 24 inches** of each carpet proposed for use, showing quality, pattern, and color specified
- c. Carpet Cushion: Two samples minimum **6 by 6 inches**

2.1.1 Recycled Content

Carpe **tile** must contain a minimum of **58** percent recycled content. Provide data identifying percentage of **recycled content for carpeting**.

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 [Multi-Level Pattern Loop](#)

2.1.3.2 Type

[Modular tile 24 inch by 24 inch square](#).

2.1.3.3 Pile Type

[Multi-Level Pattern Loop](#)

2.1.3.4 Pile Fiber

Commercial 100 percent branded (federally registered trademark) nylon continuous filament.

2.1.3.5 Gauge or Pitch

Minimum [0.1 inch](#) in accordance with [ASTM D5793](#)

2.1.3.6 Stitches or Rows/Wires

Minimum [9.8 per square inch](#)

2.1.3.7 Pile Density

Minimum [7,200 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 [0.219 inch](#) in accordance with [ASTM D6859](#)

2.1.3.9 Dye Method

Solution dyed

2.1.3.10 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 .](#)

2.1.3.11 Attached Cushion

[Provide an attached cushion mechanically frothed polyurethane with minimum weight of 18 oz/sq. yard in accordance with ASTM D3574, minimum thickness of 0.125 inch, and maximum compression resistance of 5 psi, and compression set of 15 percent in accordance with ASTM D3676. Do not exceed the maximum ash content of 50 percent when tested in accordance](#)

with ASTM D297.

2.2 PERFORMANCE REQUIREMENTS

2.2.1 Texture Appearance Retention Rating (TARR)

Provide carpet with a greater than or equal to 3.0 (Heavy) 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 3.0 kV when tested at 20 percent relative humidity and 70 degrees F in accordance with AATCC 134.

2.2.3 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.

2.2.4 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

Provide fiberglass reinforced thermoplastic cushion, with minimum 15 percent recycled content. 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 Weight

85 oz./sq. yd.

2.3.1.2 Thickness

.185 inches plus 5 percent maximum

2.3.1.3 Density

8.5-9.5 lb/cu.ft.

2.3.2 Performance Requirements - Critical Radiant Flux

Provide carpet cushion in corridors and exits with a minimum average critical radiant flux of conforming to Class 1 when tested in accordance with ASTM E648.

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 transitions according to the drawings.

2.6 COLOR, TEXTURE, AND PATTERN

Provide color, texture, and pattern in accordance with the drawings.

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.

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

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 manufacturer approved adhesive tab system permanent vinyl-compatible adhesive and snug joints. [Refer to drawings for 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. Carpet tile on stairs and sloped surfaces must be installed with a more permanent installation method in accordance with the manufacturer's instructions and with manufacturer recommended adhesives for this application.

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 00 CLOSEOUT SUBMITTALS](#). 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 feet in dimension with more than 6 square feet total to local non-profit such as Habitat for Humanity as directed by the Government.

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. Furnish three percent extra of total adhesive tabs.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 09 90 00

PAINTS AND COATINGS

02/21

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 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.

1.1.1.1 Interior Painting

Includes new surfaces of the building and appurtenances as indicated and existing coated surfaces made bare by cleaning operations. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

- a. Exposed columns, girders, beams, joists, and metal deck; and
- b. Other contiguous surfaces.

1.1.2 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, anodized aluminum, brass, and lead except existing coated surfaces.
- e. Hardware, fittings, and other factory finished items.

1.1.3 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.

1.1.3.1 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.

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 CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100 (2017; Suppl 2020) Documentation of the Threshold Limit Values and Biological Exposure Indices

ASTM INTERNATIONAL (ASTM)

ASTM D523 (2014; R 2018) Standard Test Method for Specular Gloss

ASTM D4214 (2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films

ASTM D4263 (1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

ASTM D4444 (2013; R 2018) Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters

ASTM D6386 (2016a) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

ASTM F1869 (2022) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete

Subfloor Using Anhydrous Calcium Chloride

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

Intelligence Bulletin 65 (2013) Occupational Exposure to Carbon
Nanotubes and Nanofibers

MASTER PAINTERS INSTITUTE (MPI)

MPI 9 (2016) Alkyd, Exterior Gloss (MPI Gloss Level 6)

MPI 47 (2016) Alkyd, Interior, Semi-Gloss (MPI Gloss Level 5)

MPI 50 (2015) Primer Sealer, Latex, Interior

MPI 56 (2012) Varnish, Interior, Polyurethane, Oil Modified, Gloss

MPI 57 (2012) Varnish, Interior, Polyurethane, Oil Modified, Satin

MPI 72 (2016) Polyurethane, Two-Component, Pigmented, Gloss (MPI Gloss Level 6-7)

MPI 76 (2016) Primer, Alkyd, Quick Dry, for Metal

MPI 90 (2012) Stain, Semi-Transparent, for Interior Wood

MPI 144 (2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 2)

MPI 145 (2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 3)

MPI 149 (2016) Primer Sealer, Interior, Institutional Low Odor/VOC

MPI 153 (2016) Light Industrial Coating, Interior, Water Based, Semi-Gloss (MPI Gloss Level 5)

MPI ASM (2019) Architectural Painting Specification Manual

MPI GPS-1-14 (2014) Green Performance Standard GPS-1-14

MPI GPS-2-14 (2014) Green Performance Standard GPS-2-14

MPI MRM (2015) Maintenance Repainting Manual

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Glossary (2011) SSPC Protective Coatings Glossary

SSPC PA 1 (2016) Shop, Field, and Maintenance Coating of Metals

SSPC SP 1 (2015) Solvent Cleaning
SSPC SP 2 (2018) Hand Tool Cleaning
SSPC SP 3 (2018) Power Tool Cleaning
SSPC VIS 3 (2004) Guide and Reference Photographs for
Steel Surfaces Prepared by Hand and Power
Tool Cleaning

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2014) Safety -- Safety and Health
Requirements Manual

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 (2018) 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

1.3 DEFINITIONS

1.3.1 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.

1.3.2 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.

1.3.3 Coating

SSPC Glossary; (1) A liquid, liquefiable, or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer; (2) Generic term for paint, lacquer, enamel.

1.3.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or

coating.

1.3.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five levels are generically defined under the Assessment sections in the MPI MRM, MPI Maintenance Repainting Manual.

1.3.6 INT

MPI short term designation for an interior coating system.

1.3.7 Loose Paint

Paint or coating that can be removed with a dull putty knife.

1.3.8 mil / mils

The English measurement for 0.001 in or one one-thousandth of an inch.

1.3.9 MPI Gloss Levels

MPI system of defining gloss. Seven 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 degree angle	Units at 80 degree angle
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).

1.3.10 MPI System Number

The MPI coating system number in each MPI 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).

1.3.11 Paint

SSPC Glossary; (1) Any pigmented liquid, liquefiable, or mastic

composition designed for application to a substrate in a thin layer that is converted to an opaque solid film after application. Used for protection, decoration, identification, or to serve some other functional purposes; (2) Application of a coating material.

1.3.12 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

1.4 SCHEDULING

Allow paint, polyurethane, varnish, and wood stain installations to cure prior to the installation of materials that adsorb VOCs.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Samples of specified materials may be taken and tested for compliance with specification requirements.

SD-03 Product Data

Coating; G

Product Data Sheets

SD-04 Samples

Color; G

SD-07 Certificates

Indoor Air Quality for Paints and Primers

SD-08 Manufacturer's Instructions

Mixing

Manufacturer's Safety Data Sheets

SD-10 Operation and Maintenance Data

Coatings, Data Package 1; G

1.6 QUALITY ASSURANCE

1.6.1 Regulatory Requirements

1.6.1.1 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.

1.6.1.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.6.1.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.6.1.4 Asbestos Content

Provide asbestos-free materials.

1.6.1.5 Mercury Content

Provide materials free of mercury or mercury compounds.

1.6.1.6 Silica

Provide abrasive blast media containing no free crystalline silica.

1.6.1.7 Human Carcinogens

Provide materials that do not contain ACGIH 0100 confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.6.1.8 Carbon Based Fibers / Tubes

Materials must not contain carbon based fibers such as carbon nanotubes or carbon nanofibers. Intelligence Bulletin 65 ranks toxicity of carbon nanotubes on a par with asbestos.

1.6.2 Coating Contractor's Qualification

Submit the name, address, telephone 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 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 and telephone number 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

1.6.3 Approved Products List

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.

1.6.4 Paints and Coatings Indoor Air Quality Certifications

Provide paint and coating products certified to meet indoor air quality requirements by [MPI GPS-1-14](#), [MPI GPS-2-14](#) or provide certification by other third-party programs. Provide current product certification documentation from certification body.

Provide certification of [Indoor Air Quality for Paints and Primers](#). Submit required indoor air quality certifications in one submittal package.

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](#). [Do not store paint, polyurethane, varnish, or wood stain products with materials that have a high capacity to absorb VOC emissions. Do not store paint, polyurethane, varnish, or wood stain products in occupied spaces.](#)

1.8 SAFETY AND HEALTH

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 29 SAFETY AND OCCUPATIONAL HEALTH 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 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 REQUIREMENTS

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.

1.9.2 Post-Application

Vacate space for as long as possible after application. Wait a minimum of 48 hours before occupying freshly painted rooms. Maintain one of the following ventilation conditions during the curing period, or for 72 hours after application:

- a. Supply 100 percent outside air 24 hours a day.
- b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 85 degrees F and humidity is between 30 percent and 60 percent.
- c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

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, pot life, and curing and drying times between coats.

2.2 COLOR SELECTION OF FINISH COATS

Provide colors of finish coats as indicated or specified. Allow Contracting Officer to select colors not indicated or specified. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for use only if

they conform to specified requirements. Products of other manufacturers are acceptable if the colors are approximately the colors indicated and the product conforms to specified requirements.

Provide color, texture, and pattern of wall coating systems as indicated. Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated. Submit color stencil codes. Tint each coat progressively darker to enable confirmation of the number of coats.

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. Refer to **MPI ASM** and **MPI MRM** for additional more specific substrate preparation requirements.

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 so that when tested in accordance with **ASTM D4214**, the chalk rating is not less than 8.

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 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 3**.
Protect shop-coated ferrous surfaces from corrosion by treating and touching up corroded areas immediately upon detection.

3.3.2 Final Ferrous Surface Condition:

3.3.2.1 Tool Cleaned Surfaces

Comply with [SSPC SP 2](#) and [SSPC SP 3](#). Use as a visual reference, photographs in [SSPC VIS 3](#) 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, or non-alkaline detergent solution 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.

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, Chalking, Grease, and Oil: Wash new 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.
- 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 manufacturer's recommendations. Allow surfaces to cure a minimum of 30 days before painting.

3.5 PREPARATION OF WOOD AND PLYWOOD SURFACES

3.5.1 New Wood Surfaces:

- a. Surface Cleaning: Clean wood surfaces of foreign matter. 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.
- b. 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.

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

- a. Comply with applicable federal, state and local laws enacted to ensure 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.
- b. At the time of application, paint must show no signs of deterioration. Maintain uniform suspension of pigments during application.
- c. 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.
- d. Only apply paints, except water-thinned types, to surfaces that are completely free of moisture as determined by sight or touch.
- e. 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.
- f. 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.
- g. Touch up damaged coatings before applying subsequent coats.
- h. Apply paint to new fireextinguishing 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. 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. Upon completion of painting, remove protective covering from sprinkler heads.
- i. Piping in Unfinished Areas: Provide primed surfaces with one coat of red alkyd gloss enamel (MPI 9) 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.

- j. 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 (MPI 9) applied to a minimum dry film thickness of 1.0 mil or two component gloss polyurethane (MPI 72) in exterior applications.
- k. Provide labeling on the surfaces of all feed and cross mains to show the pipe function such as "Sprinkler System", "Fire Department Connection", "Standpipe". For pipe sizes 4-inch and larger provide white painted stenciled letters and arrows, a minimum of 2 in in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 4-inch, provide white painted stenciled letters and arrows, a minimum of 0.75 in in height and visible from the floor.
- l. All fire suppression system valves must be marked with permanent tags indicating normally open or normally closed.
- m. 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.
- n. 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.
- o. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

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 one 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 for Interior Applications	
MPI Division	Substrate Application
MPI Division 5	Interior Metal, Ferrous and Non-Ferrous Paint Table
MPI Division 6	Interior Wood Paint Table
MPI Division 9	Interior Gypsum Board 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 unspecified surfaces 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 MPI Division 5 for Interior.

- a. Apply specified ferrous metal primer to steel surfaces 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. 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.

3.8 COATING SYSTEMS FOR CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in MPI Division 4 for Interior.

3.9 COATING SYSTEMS FOR WOOD

- a. Apply coatings of Tables in MPI Division 6 for Interior.
- b. Apply stains in accordance with manufacturer's printed instructions.

3.10 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.

3.11 PAINT TABLES

All DFT's are minimum values. Use only materials with a MPI GPS-1-14 green check mark having a minimum MPI "Environmentally Friendly" E2 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>.

3.11.1 Interior Paint Tables

3.11.1.1 MPI Division 5: Interior Metal, Ferrous and Non-Ferrous Paint Table

A. Interior Steel / Ferrous Surfaces

(1) Metal, Fire extinguishing sprinkler systems including valves, conduit, hangers, supports, Surfaces adjacent to painted surfaces (Match surrounding finish), and miscellaneous metal items

Alkyd				
New	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1E-G5 (Semigloss)	MPI 76	MPI 47	MPI 47	5.25 mils

Topcoat: Coating to match adjacent surfaces.				

B. Galvanized Metal Decking

Interior overhead steel structural members and galvanized metal decking coatings are modified alkyd paint with 36% to 49% solids by volume, 3.30 to 3.34 pounds VOC per gallon and flat finish. Coatings settle as a dry powder in approximately ten feet depending on temperature, humidity and air movement. Do not thin. Clean with xylene. Furnish compatible primers.

C. Galvanized Balustrades and Handrails

Galvanized and paint grip galvanized coatings are a waterborne acrylic paint with 36% solids by volume, 0.76 pounds VOC per gallon and a semi gloss finish. Coatings are highly durable with an all purpose finish. Do not thin. Clean with water. Furnish compatible primers.

3.11.1.2 MPI Division 6: Interior Wood Paint Table

A. Interior New Wood Doors; Natural Finish or Stained

Natural finish, oil-modified polyurethane					
New	New doors	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.3K-G4	MPI RIN 6.3K-G4	MPI 57	MPI 57	MPI 57	4 mils
MPI INT 6.3K-G6 (Gloss)	MPI RIN 6.3K-G6 (Gloss)	MPI 56	MPI 56	MPI 56	4 mils
Note: Sand between all coats per manufacturers recommendations. Match the color and gloss of doors in the adjoining buildig.					

Stained, oil-modified polyurethane						
New	New doors	Stain	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.3E-G4	MPI RIN 6.3E-G4	MPI 90	MPI 57	MPI 57	MPI 57	4 mils
MPI INT 6.5B-G6 (Gloss)	MPI RIN 6.5B-G6 (Gloss)	MPI 90	MPI 56	MPI 56	MPI 56	4 mils

Note: Sand between all coats per manufacturers recommendations. Match the color and gloss of doors in the adjoining building.

3.11.1.3 MPI Division 9: Interior Gypsum Board Paint Table A. Interior New Wallboard not otherwise specified Institutional Low Odor / Low VOC Latex, New

Institutional Low Odor / Low VOC Latex				
New	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2M-G2 (Flat)	MPI 149	MPI 144	MPI 144	4 mils
MPI INT 9.2M-G3 (Eggshell)	MPI 149	MPI 145	MPI 145	4 mils
Provide Eggshell finishes for walls and Flat finishes for ceilings.				

B. Interior New Wallboard in toilets, laundry areas, shower areas, and other high humidity areas not otherwise specified

Waterborne Light Industrial Coating					
New		Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2L-G5 (Semigloss)		MPI 50	MPI 153	MPI 153	4 mils

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 10 14 00.20

INTERIOR SIGNAGE
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 in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45 (2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AA PK-1 (2015) Pink Sheets: Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings & Ingot

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

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2/D1.2M (2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

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

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1 COMM (2017) Standard And Commentary Accessible and Usable Buildings and Facilities

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2021; TIA 21-1) Life Safety Code

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. Submit the following in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

SD-03 Product Data

Installation; G

Warranty; G

SD-04 Samples

Interior Signage; G

Software; G

SD-10 Operation and Maintenance Data

Approved Manufacturer's Instructions; G

Protection and Cleaning; G

1.3 EXTRA MATERIALS

Provide 3 extra frames and extra stock of the following: blank plates of each color and size for each sign type. Provide 3 extra changeable message strips for each sign type. Provide 3 paper inserts per sign 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.

1.4 QUALITY ASSURANCE

1.4.1 Samples

Submit interior signage samples of each of the following sign types showing typical quality, workmanship and color: Directional sign, Standard Room sign, Changeable message strip sign. The samples may be installed in the work, provided each sample is identified and location recorded.

1.4.2 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.

1.5 DELIVERY, STORAGE, AND HANDLING

Materials must be packaged to prevent damage and deterioration during shipment, handling, storage and installation. Product must be delivered

to the jobsite in manufacturer's original packaging and stored in a clean, dry area in accordance with manufacturer's instructions.

1.6 WARRANTY

Warrant the interior signage for a period of 2 years against defective workmanship and material. Warranties must 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, plaques, directories, and dimensional letters must 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/DIRECTIONAL SIGNAGE SYSTEM

2.2.1 Standard Room Signs

Signs must incorporate an ABS plastic face with applied graphics including all tactile requirements in adherence to ABA and ADA requirements. All signs must have matching appearance and construction utilizing the same manufacturing process to assure consistent look and quality and must conform to the following:

- a. Signage must utilize an acrylic sphere for Grade II Braille inserted directly into a scratch resistant, high pressure laminate sign face. Braille dots are to be pressure fit in high tolerance drilled holes. Braille dots must be half hemispherical domes, protruding a minimum of 0.025".
- b. End caps must be aluminum style corners.
- c. Tactile Lettering must be precision machined, raised 1/32", matte PETG and subsurface colored for scratch resistance..

2.2.2 Changeable Message Strip Signs

Changeable message strip signs must 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 must 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. Clear sleeve must be removable without any special tools.

2.2.3 Type of Mounting For Signs

Provide extruded aluminum brackets for hanging, projecting, and double-sided signs. Mounting for framed, hanging, and projecting signs

must be by mechanical fasteners. Surface mounted signs must be mounted with countersunk mounting holes in plaques and mounting screws. All signs must be provided with appropriate mounting hardware for the wall substrate. Hardware must be finished and architectural in appearance. Some signs may be mounted on glass. A blank backer is required.

2.2.4 Graphics

Signage graphics for modular signs must 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 must 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 must be clean.

2.2.4.3 Surface Applied Photopolymer

Integral graphics and Braille achieved by photomechanical stratification processes. Photopolymer used for ADA compliant graphics must be of the type that has a minimum durometer reading of 90. Tactile graphics must be raised 1/32 inch from the first surface of plaque by photomechanical stratification process.

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 must conform to 36 CFR 1191.

2.3 STAIR SIGNAGE

Provide signs on stairs serving three or more stories with special signage within the enclosure at each floor landing conforming to NFPA 101. Indicate the floor level, the terminus of the top and bottom of the stair enclosure, and the identification of the stair enclosure. Also, state the floor level of, and the direction to, exit discharge. Locate the signage inside the enclosure in a position that is visible when the door is in the open or closed position and install in conformance with 36 CFR 1191. The floor level designation must also be tactile in accordance with ICC A117.1 COMM.

2.4 BUILDING DIRECTORIES

Building directories must be lobby directories or floor directories, and must be provided with a changeable directory listing consisting of the areas, offices and personnel located within the facility. Dimensions, details, and materials of sign and message content must be as shown on the

drawings.

2.5 ALUMINUM ALLOY PRODUCTS

Aluminum extrusions must be at least 1/8 inch thick, and aluminum plate or sheet must be at least 0.0508 inch thick. Extrusions must conform to ASTM B221; plate and sheet must conform to ASTM B209. Where anodic coatings are specified, alloy must conform to AA PK-1 alloy designation 514.0. Exposed anodized aluminum finishes must be as shown. Welding for aluminum products must conform to AWS D1.2/D1.2M.

2.6 ANODIC COATING

Anodized finish must conform to AA DAF45 as follows:

- a. Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.4 mil or thicker.

2.7 ORGANIC COATING

Organic coating must conform to AAMA 2604, with total dry film thickness not less than 1.2 mils.

2.8 FABRICATION AND MANUFACTURE

2.8.1 Factory Workmanship

Holes for bolts and screws must be drilled or punched. Drilling and punching must produce clean, true lines and surfaces. Exposed surfaces of work must have a smooth finish and exposed riveting must be flush. Fastenings must be concealed where practicable.

2.8.2 Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

2.9 COLOR, FINISH, AND CONTRAST

Color must be as indicated on the drawings. Finish of all signs must be eggshell, matte, or other non-glare finish as required in handicapped-accessible buildings.

2.10 TYPEFACE

ADA-ABA compliant font for Room Signs.

PART 3 EXECUTION

3.1 INSTALLATION

Signs must be installed plumb and true and in accordance with approved manufacturer's instructions at locations shown on the detail drawings. Submit six copies of operating instructions outlining the step-by-step procedures required for system operation. The instructions must 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 must be permanently bound and must have a hard cover. The following

identification must 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 must conform to 36 CFR 1191. Required blocking must be installed. Signs on doors or other surfaces must not be installed until finishes on such surfaces have been installed. Signs installed on glass surfaces must be installed with matching blank back-up plates in accordance with manufacturer's instructions.

Do not install items that show visual evidence of biological growth.

3.1.1 Anchorage

Anchorage must be in accordance with approved manufacturer's instructions. In high humidity interior spaces (for example, bathrooms, locker rooms, pools, trainers) and unconditioned spaces, use corrosion-resistant anchors/fasteners or with approval by the manufacturer, waterproof silicone adhesive. Anchorage not otherwise specified or shown must 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 must be compatible with metal to which applied and must have matching color and finish. At interior applications in heavy traffic areas, firmly attach signage to structure walls with tamper-proof fasteners.

- a. Signs mounted to painted gypsum board surfaces must 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.
- e. Install signs mounted on doors or glass must use manufacturers recommended adhesive.

3.1.2 Protection and Cleaning

Protect the work against damage during construction. Hardware and electrical equipment must be adjusted for proper operation. Glass, frames, and other sign surfaces must 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 six copies of maintenance instructions listing routine procedures, repairs, and guides.

-- End of Section --

SECTION 10 21 13

TOILET COMPARTMENTS
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.

ALUMINUM ASSOCIATION (AA)

AA DAF45 (2003; Reaffirmed 2009) Designation System
for Aluminum Finishes

ASTM INTERNATIONAL (ASTM)

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 A385/A385M (2020) Standard Practice for Providing
High-Quality Zinc Coatings (Hot-Dip)

ASTM D7611/D7611M (2013; E 2014) Standard Practice for
Coding Plastic Manufactured Articles for
Resin Identification

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1 (2017) Standard And Commentary Accessible
and Usable Buildings and Facilities

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60003 (Basic; Notice 1) Partitions, Toilet,
Complete

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance

with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

Installation Drawings; G

SD-03 Product Data

Cleaning and Maintenance Instructions

Colors And Finishes

Anchoring Devices and Fasteners

Hardware and Fittings

Brackets

Door Hardware

Toilet Enclosures

Urinal Screens

Pilaster Shoes

Finishes; G

SD-04 Samples

Colors and Finishes; G

Hardware and Fittings

Anchoring Devices and Fasteners

SD-07 Certificates

Warranty

SD-10 Operation and Maintenance Data

Plastic Identification; G

1.3 CERTIFICATIONS

1.4 REGULATORY REQUIREMENTS

Comply with to ICC A117.1 code for access for the handicapped operation of toilet compartment door and hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the manufacturer's original unopened packages with the brand, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated; free from dust, water, other contaminants, and damage during delivery, storage,

and construction.

1.6 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for a period of one year from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

Provide a complete and usable toilet partition system, including toilet enclosures, room entrance screens, urinal screens, system of panels, hardware, and support components. Furnish the partition system from a single manufacturer, with a standard product as shown in the most recent catalog data. Submit [Fabrication Drawings](#) for toilet partitions and urinal screens consisting of fabrication and assembly details to be performed in the factory. Submit manufacturer's [Cleaning and Maintenance Instructions](#) in accordance with Section [01 78 23 OPERATIONS AND MAINTENANCE DATA](#).

2.1.1 Plastic Identification

Verify that plastic products to be incorporated into the project are labeled in accordance with [ASTM D7611/D7611M](#). Where products are not labeled, provide product data indicating polymeric information in the Operation and Maintenance Manual.

Type 2	High Density Polyethylene (HDPE)

2.2 MATERIALS

2.2.1 Solid Polyethylene Panels (Finish 5)

Provide high density polyethylene (HDPE) suitable for exposed application. Waterproof, non-absorbent and graffiti resistant textured surface with a Flame Spread Index of 75 or less, and a Smoke Developed Index of 450 or less.

2.2.2 Anchoring Devices and Fasteners

Provide steel anchoring devices and fasteners hot-dipped galvanized after fabrication, in conformance with [ASTM A385/A385M](#) and [ASTM A123/A123M](#).

Conceal all galvanized anchoring devices.

2.2.3 Brackets

Provide two-ear panel wall brackets, T-style, 1 inch stock. Provide stirrup style panel-to-pilaster brackets.

2.2.4 Hardware and Fittings

2.2.4.1 General Requirements

Provide hardware for the toilet partition system that complies with CID A-A-60003 for the specified type and style of partitions. Provide hardware finish highly resistant to alkalis, urine, and other common toilet room acids. Comply with 36 CFR 1191 of latching devices and hinges for handicap compartments; provide stainless steel devices and hinges with door latches that operate without either tight grasping or twisting of the wrist of the operator. Submit three samples of each item, including anchoring devices and fasteners. Approved hardware samples may be installed in the work if properly identified.

Material	Conformance Standard
Corrosion-resistant steel	ASTM A167, Type 302

2.2.4.2 Finishes

- a. Provide stainless steel with a No. 4 finish.
- f. Provide exposed fasteners that match the hardware and fittings.

2.2.5 Door Hardware

2.2.5.1 Hinges

Provide adjustable hinges to hold in-swinging doors open at any angle up to 90 degrees and outswinging doors up to 10 degrees. Provide self-lubricating hinges with the indicated swing. Provide hinges that are surface-mounted type and have the following type of return movement:

- a. Gravity return movement

2.2.5.2 Latch and Pull

Provide latch and pull that is a combination rubber-faced door strike and keeper equipped with emergency access. Provide surface mounted latch.

2.2.5.3 Coat Hooks

Provide coat hooks that are combination units with hooks and rubber tipped pins.

2.3 PARTITION PANELS AND DOORS

Fabricate partition panels, and pilasters of materials and construction listed:

Provide plastic (HDPE) partition panels, doors and pilasters not less than 1 inch thick.

Provide solid polyethylene toilet partitions and screens with recycled content of 30 percent minimum.

2.3.1 Toilet Enclosures

Provide toilet enclosures that comply with CID A-A-60003, Type I, Style C, overhead braced. Furnish width, length, and height of toilet enclosures as shown. Finish surface of panels are solid polyethylene (Finish 5); water resistant; graffiti resistant; non-absorbent radius beveled edges. Reinforce panels indicated to receive toilet paper holders or grab bars for mounting of the items required, and provide cut outs for through partition toilet accessories. Provide grab bars to withstand a bending stress, shear stress, shear force, and a tensile force induced by 250 lbf. Grab bars cannot rotate within their fittings.

2.3.2 Urinal Screens

Provide urinal screens that comply with CID A-A-60003, Type III, Style A, floor supported. Provide finish for surface of screens as solid polyethylene (Finish 5); water resistant; graffiti resistant; non-absorbent with radius beveled edges; with manufacturer's standard post design of materials matching the thickness and construction of pilasters. Furnish width and height of urinal screens as shown. Provide thickness to match toilet compartment panel construction. Secure wall hung urinal screens with 42 inches long, continuous flanges. Fabricate screens from the same types of panels and pilasters as the toilet partitions. Use corrosion-resistant steel fittings and fasteners.

2.4 OVERHEAD-BRACED PARTITIONS

Provide pilasters in sizes indicated that are manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism. Provide anchoring device at the bottom of the pilaster consisting of a channel-shaped floor stirrup fabricated from not less than 0.0635 inch thick material and a leveling bolt. Secure the stirrup to the pilaster with not less than a 3/16 inch bolt and nut after the pilaster is leveled. Secure the stirrup to the floor with not less than two lead expansion shields and sheetmetal screws. Fabricate overhead brace from a continuous extruded aluminum tube not less than 1 inch wide by 1-1/2 inch high, 0.125 inch wall thickness. Finish is AA-C22A31 in accordance with AA DAF45. Set and secure brace into the top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.

2.5 PILASTER SHOES

Provide shoes at pilasters to conceal floor-mounted anchorage. Provide one piece molded HDPE pilaster shoes. Height is a minimum 3 inches.

2.6 HARDWARE

Provide hardware for the toilet partition system that complies with CID A-A-60003 for the specified type and style of partitions. Provide hardware pre-drilled by manufacturer. Use a hardware finish that is highly resistant to alkalis, urine, and other common toilet room acids. Hardware includes: chrome plated nonferrous cast pivot hinges, gravity type, adjustable for door close positioning; nylon bearings; chrome plated aluminum door latch; door strike and keeper with rubber bumper; and cast alloy chrome plated coat hook and bumper. Provide latching devices and hinges for handicap compartments complying with 36 CFR 1191 and stainless steel door latches that operate without either tight grasping or twisting of the wrist of the operator. Use stainless steel, tamper proof type screws and bolts. Wall mounting brackets are continuous, full height, stainless steel, in accordance with toilet compartment manufacturer's instructions.. Provide floor-mounted anchorage consisting of corrosion-resistant anchoring assemblies with threaded rods, lock washers, and leveling adjustment nuts at pilasters for structural connection to floor.

2.7 COLORS AND FINISHES

2.7.1 Colors

Provide color as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers.

Color of pilaster shoes matches the core of solid plastic compartments and screens. Submit three samples showing color and a finished edge on two adjacent sides and core construction, each not less than 12 inch square.

2.7.2 Finishes

2.7.2.1 Finishes No. 4, No 4A and No. 5

Provide manufacturer's standard solid polyethylene (Finish 5) formed under high pressure rendering a single component section not less than 1 inch thick. Colors extend throughout the panel thickness.

PART 3 EXECUTION

3.1 PREPARATION

Take field measurements prior to the preparation of drawing and fabrication to ensure proper fits. Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive work. Verify correct spacing of plumbing fixtures. Verify correct location of built in framing, anchorage, and bracing. Report in writing to Contracting Officer prevailing conditions that adversely affect satisfactory execution of the work of this section. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

Do not install items that show visual evidence of biological growth. Install partitions rigid, straight, plumb, and level, with the panels centered between the fixtures. Provide a panel clearance of not more than $1/2$ inch and secure the panels to walls and pilasters with continuous full height wall brackets. Locate wall brackets so that holes for wall bolts occur in masonry or tile joints. Secure panels to pilasters with brackets matching the wall brackets. Provide for adjustment due to minor floor variations. Locate head rail joints at pilaster center lines. Install adjacent components for consistency of line and plane. Equip each door with hinges, one door latch, and one coat hook and bumper. Align hardware to uniform clearance at vertical edges of doors.

- a. Secure panels to hollow plastered walls with toggle bolts using not less than $1/4$ -20 screws of the length required for the wall thickness. Provide toggle bolts with a load-carrying strength of not less than 600 pounds per anchor.
- b. Secure panels to ceramic tile on hollow plastered walls or hollow concrete-masonry walls with toggle bolts using not less than $1/4$ -20 screws of the length required for the wall thickness. Provide toggle bolts with a load-carrying strength of not less than 600 pounds per anchor.
- c. Secure panels to solid masonry or concrete with lead or brass expansion shields designed for use with not less than $1/4$ -20 screws, with a shield length of not less than $1-1/2$ inches. Provide expansion shields with a load-carrying strength of not less than 600 pounds per anchor.
- d. Submit [Installation Drawings](#) for toilet partitions, room entrance screens, and urinal screens showing plans, elevations, details of construction, hardware, reinforcing and blocking, fittings, mountings and escutcheons. Indicate on drawings the type of partition, location, mounting height, cutouts, and reinforcement required for toilet-room accessories.

3.3 OVERHEAD-BRACED PARTITIONS

Secure pilasters to the floor with the anchorage device specified. Make all leveling devices readily accessible for leveling, plumbing, and tightening the installation. Secure overhead brace to the pilaster face with not less than two fasteners per face. Expansion shields have a minimum 2 inch penetration into the concrete slab. Make tops of doors parallel with the overhead brace when doors are in a closed position.

3.4 FINAL ADJUSTMENT

After completion of the installation, make final adjustments to the pilaster-leveling devices, door hardware, and other working parts of the partition assembly. Doors have a uniform vertical edge clearance of approximately $3/16$ inch and rest open at approximately 30 degrees when unlatched.

3.5 CLEANING

Clean all surfaces and adjacent surfaces soiled as a result of the work,

in an approved manner compliant with the manufacturer's recommended cleaning and protection from damage procedures until accepted. Remove all equipment, tools, surplus materials, and work debris from the site.

-- End of Section --

SECTION 10 26 00

WALL AND DOOR PROTECTION

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 A240/A240M (2020a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

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" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Corner Guards; G

SD-03 Product Data

Corner Guards; G

SD-04 Samples

Finish; G

SD-06 Test Reports

Corner Guards

SD-07 Certificates

Corner Guards

Indoor air quality for adhesives

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality

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 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 corner guards 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.

2.2 CORNER GUARDS

2.2.1 Stainless Steel Corner Guards

Stainless steel corner guards must be fabricated of **16 gauge** thick material conforming to **ASTM A240/A240M**, type 302 or 304. Corner guards

must extend from floor to ceiling. Edges of corner guards must be finished to a smooth edge with no cut, unfinished edges showing. Install corner guards in locations as shown on the drawings. Refer to drawings for finish.

2.3 TRIM, FASTENERS AND ANCHORS

Provide vinyl trim, fasteners and anchors for resilient installation as shown. Provide stainless steel trim, fasteners and anchors for stainless steel corner guards. All trim, fasteners and anchors must be concealed after installation.

2.4 FINISH

Submit three samples indicating color and texture of materials requiring color and finish.

2.4.1 Stainless Steel Finish

Finish for stainless steel must be in accordance with ASTM A240/A240M, Type 302 or 304, finish number 4.

2.5 ADHESIVES

Adhesive for metal material must be in accordance with manufacturers recommendations. Corner guard must be mechanically fastened. All mounting hardware must be hidden with finished product. 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.

2.6 COLOR

Color must be as indicated on the drawings. Color listed is 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.

3.1.1 Corner Guards

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 as in accordance with manufacturer's recommendations for a mechanically fastened installation.
- b. Where corner guards are installed on walls, partitions or columns finished with plaster or ceramic tile on steel or wood stud, anchor

corner guards with number 10 1 1/2 inch S/S flat head wood screws. Coat back surfaces of corner guards, where shown, with a non-flammable, sound deadening material. Corner guards must overlap finish plaster surfaces.

- c. Where corner guards are installed on exposed structural glazed facing tile units or masonry wall, partitions or columns, anchor corner guards with number 10 X 1 1/2 inch S/S flat head wood screw and AF-8 plastic anchors. Grout spaces solid between guards and backing with portland cement and sand mortar.
- d. 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.
- e. For wall guards, space brackets at no more than 3 feet on centers and anchor to the wall in accordance with the manufacturer's installation instructions.

-- End of Section --

SECTION 10 28 13

TOILET ACCESSORIES
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.

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-1691

(1994; Rev F) Construction and Material
Schedule for Military Medical and Dental
Facilities

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Product Schedule

Submit product Schedule indicating types, quantities, sizes, and installation locations by room for each toilet accessory item required. Identify locations using room designations indicated on the drawings.

SD-03 Product Data

Recycled content for stainless steel toilet accessories; S

Paper Towel Dispenser (PTD), SS, Surface Mounted; G

Sanitary Napkin Disposal (SND), SS, Surface Mounted; G

Grab Bar (GB36) (GB42), 1-1/4 inch Dia., SS, W/C Accessible; G

Shelf, Mop and Broom Holder (MHS), SS, Surf Mntd; G

Robe Hook (RH), Security;G

Shower Curtain Rod (SCR), 1 inch Diameter, W/Curtain & Hooks; G

Toilet Tissue Dispenser (TTD), SS, 1-Roll, Surface Mntd; G

Wall Mirror (WM); G

Foam Soap Dispenser (SD); G

Semi Recessed Waste Receptacle and Paper Towel Dispenser (ITDW); G

Submit catalog numbers, literature, data sheets, construction details, profiles, anchoring and mounting requirements ,including cutouts in other work and substrate preparation, electrical characteristics, and other pertinent data for each toilet accessory item to evaluate function, materials, dimensions and appearance.

SD-10 Operation and Maintenance Data

Paper Towel Dispenser (PTD), SS, Surface Mounted

Sanitary Napkin Disposal (SND), SS, Surface Mounted

Grab Bar (GB36) (GB42), 1-1/4 inch Dia., SS, W/C Accessible

Shelf, Mop and Broom Holder (MHS), SS, Surf Mntd

Robe Hook (RH), Security

Shower Curtain Rod (SCR), 1 inch Diameter, W/Curtain & Hooks

Toilet Tissue Dispenser (TTD), SS, 1-Roll, Surface Mntd

Wall Mirror (WM)

Foam Soap Dispenser (SD);G

Semi Recessed Waste Receptacle and Paper Towel Dispenser (ITDW)

Submit Data Package 1 for each toilet accessory item , and Data Package 2 for each electrical toilet accessory item, in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

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 warranty to repair or replace defective materials and workmanship for a period of one year from date of final acceptance of the work..

PART 2 PRODUCTS

2.1 ACCESSORY ITEMS

Provide toilet accessories where indicated in accordance with Contractor-provided [product schedule](#). Conform to the requirements for accessory items specified herein which are based on [MIL-STD-1691](#) Joint Schedule Numbers (JSN). 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.

2.1.1.1 Anchors and Fasteners

Provide corrosion-resistant 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 oval heads exposed fasteners with finish to match the accessory. Provide fasteners proposed for use for each type of wall construction and mounting.

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

2.1.3 Paper Towel Dispenser (PTD), SS, Surface Mounted

Surface mounted unit constructed of stainless steel with satin finish, welded construction, and have full length piano hinge, tumbler lock, refill indicator. Unit has smooth corners, free of burrs and sharp edges. Unit has a capacity of 400 C-fold paper towels.

Approximate size: 11 inches wide by 8 inches high by 6 inches deep.

2.1.4 Sanitary Napkin Disposal (SND), SS, Surface Mounted

Surface mounted sanitary napkin receptacle. Unit made of stainless steel with satin finish and all welded construction. Unit has piano hinge attached at the top and an integral finger depression for opening. For use with disposable paper liners, available separately. Unit may be attached to wall or toilet partition.

Approximate size: 7 inches wide by 4 inches deep by 10 inches high.

2.1.5 Grab Bar (GB36) (GB42), 1-1/4 inch Dia., SS, W/C Accessible

Grab bar of 1-1/4 inch diameter satin finish stainless steel with peened gripping surface for use in toilet stall/room. Snap-on flange covers for concealed mounting are stainless steel and equipped with two screw holes for attachment to wall. Grab bars designed to meet and exceed ADA requirements for structural strength. Grab bars designed to withstand loads of 900 pounds when properly installed. Clearance from wall to grab bar is 1-1/2 inches to meet ADA and ANSI codes.

2.1.6 Shelf, Mop and Broom Holder (MHS), SS, Surf Mntd

Surface mounted mop/broom holder with shelf made of 18 gauge stainless steel with all exposed surfaces in satin finish. Unit has shelf 8 inches deep with shelf support brackets of satin finish stainless steel welded to mounting base, and a minimum of 3 hooks/3 holders. Mop holders have spring-loaded rubber cams and hold mop or broom handle with a diameter

between 5/8 inch and 1 inch.

Approximate size: 36 inches wide by 8 inches deep.

2.1.1.7 Robe Hook (RH), Security

Surface mounted safety hook made of stainless steel and secured to wall with tamper resistant mounting screws, exposed mounting. Mounting hardware to be included. Hook designed to snap down when it exceeds load limit.

2.1.1.8 Shower Curtain Rod (SCR), 1 inch Diameter, W/Curtain & Hooks

Shower Curtain Rod with concealed mounting. Shower curtain rod made of satin finish stainless steel, 1 inch diameter, with flanges included.

2.1.1.9 Toilet Tissue Dispenser (TTD), SS, 1-Roll, Surface Mntd

Concealed surface mounted single roll toilet tissue dispenser of satin finish stainless steel. Spindle to be free-spinning for non-controlled delivery, chrome-plated high impact resistant plastic and equipped with heavy-duty internal spring. Unit accommodates standard core toilet paper roll up to 5-1/2 inches diameter. Mounting hardware included.

Approximate size: 7-3/4 inches wide by 2 inches high by 4 inches deep.

2.1.1.10 Wall Mirror (WM)

Mirror frames are 0.050 inch, 18 gauge Type 304 stainless steel angles fabricated into 0.75 inch by 0.625 inch channels with mitered, heilarc welded corners that are ground and polished smooth. Concealed members are corrosion protected steel. Fabricate mirror backs with 0.036 inch, 20 gauge back panels incorporating 0.050 inch, 18 gauge mounting brackets interlocked with frame tops and bottoms. Place filler material at mirror edges, and between mirrors and back panels. Mirrors are first quality, electrolytic copper backing on 0.25 inch plate or float glass, complying with ASTM C 1036 and ASTM C 1503.

Approximate size: 1 foot, 6 inches wide by 3 feet, 0 inches high.

2.1.1.11 Foam Soap Dispenser (SD) Surface Mounted

Foam soap dispensers have chrome plated, ABS plastic valves incorporated into 0.038 inch, 20 gauge Type 304 stainless steel bodies and backs. Wall plates are stainless steel. Units have 40 fluid ounces of capacity, and are top filled through locked openings. Surface mount with a vertical orientation. Valves actuate with no more than 5 pounds of pressure. Furnish tamper resistant sight level indicators. Provide two keys per unit.

Approximate size: 4.8125 inches wide by 8.25 inches high by 2.825 inches deep and valves project 1.6875 inches.

2.1.1.12 Semi Recessed Waste Receptacle and Paper Towel Dispenser (ITDW)

Semi recessed waste receptacle and paper towel dispenser units hold 800 multi-fold or 600 C-fold paper towels. Waste receptacles accommodate 12 gallon liners. Unit doors, frames, waste containers and cabinets are 18-8 alloy, Type 304 stainless steel. Unit doors and backs are 0.050 inch, 18

gauge, and other fabrications are 0.031 inch, 22 gauge. Exposed surfaces are protected by PVC film. Doors are fabricated of double pan construction with fiberboard filler, have full length, 0.1875 inch diameter multi staked, stainless steel piano hinges and are fit with tumbler locks. Towel dispensing slots have hemmed edges for user safety. Waste containers have hemmed edges and are secured with tumbler locks. Face trims are 1 inch in width and formed from a single piece free of miters, welds and open seams with a 0.25 inch square return to walls. Structural components are of welded construction. Cabinet fasteners and spot welds are concealed. Labeling provides operating instructions.

Outside flange dimensions are 1 foot, 5.25 inches wide, 4 feet, 8 inches high and recessed 1.25 inches into wall substrates. Units project 2.75 inches from wall faces.

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 Surface Mounted Accessories

Mount on concealed backplates, unless specified otherwise. Conceal fasteners on accessories without backplates. Install accessories with corrosion-resistant 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 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.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 10 44 16

FIRE EXTINGUISHERS
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.

ASTM INTERNATIONAL (ASTM)

ASTM E814 (2013a; R 2017) Standard Test Method for
Fire Tests of Penetration Firestop Systems

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cabinets; G

Wall Brackets; G

SD-03 Product Data

Accessories; G

Cabinets; G

Wall Brackets; G

Replacement Parts List; G

SD-04 Samples

Equipment Samples; G

1.3 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.

1.3.1 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.

1.4 PROJECT SCHEDULE

For fire extinguishers, Coordinate final fire protection cabinet schedule with extinguishers to ensure proper fit and function. Use same designations indicated on Drawings.

PART 2 PRODUCTS

Submit fabrication drawings consisting of fabrication and assembly details performed in the factory and product data for the following items:
Accessories, cabinets, Wall Brackets.

2.1 EQUIPMENT

2.1.1 Cabinets

2.1.1.1 Material

Provide enameled steel cabinets.

2.1.1.2 Type

Provide a semi-recessed fire rated cabinet, listed and labeled to comply with ASTM E814 for fire resistance wall rating.

2.1.1.3 Size

Dimension cabinets to accommodate the specified fire extinguishers.

2.1.2 Wall Brackets

Provide running-board fire extinguisher wall brackets.

Provide wall bracket and accessories as approved.

2.1.2.1 Identification

Provide lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by the drawings.

Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

Orientation: Vertical.

PART 3 EXECUTION

3.1 INSTALLATION

Install fire extinguishers 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.

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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 12 24 13

ROLLER WINDOW SHADES
08/20

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

Provide roller window shades, complete with necessary brackets, fittings, and hardware as indicated on the drawings. Mount and operate equipment in accordance with manufacturer's instructions. Windows to receive a shade must be completely covered.

- a. Submit drawings showing plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to adjacent work. Include the use of same room designations as indicated on the drawings.
- b. Provide manufacturer's data composed of catalog cuts, brochures, product information, and operating and maintenance instructions on each product that must be used. Include styles, profiles and features.
- c. Furnish samples of each type and color of roller shade fabric and roller shade channel. Shade material must be minimum 6 by 6 inch in size. Mark face of material to indicate interior faces.
- d. Mock up: Install shade in area designated by Contracting Officer. Do not proceed with remaining work until the Contracting Officer approves workmanship and operation. Re-work mock-up as required to produce acceptable work. The approved shade can be used in installation.
- e. Submit fire resistance data, flame spread and smoke contribution data.

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.

ASTM INTERNATIONAL (ASTM)

ASTM G21 (2015; R 2021; E 2021) Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

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

UNDERWRITERS LABORATORIES (UL)

UL 2818	(2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings
UL 325	(2017; Reprint Feb 2020) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems

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. Submit the following in accordance with Section 01 33 00
SUBMITTAL PROCEDURES

SD-02 Shop Drawings

Installation; G

SD-03 Product Data

Window Shades; G

Recycled Content for various fiber components

SD-04 Samples

Window Shades; G

SD-06 Test Reports

Window Shades

SD-07 Certificates

Indoor Air Quality for roller window shades

SD-08 Manufacturer's Instructions

Window Shades

SD-10 Operation and Maintenance Data

Window Shades

SD-11 Closeout Submittals

Warranty; G

1.4 CERTIFICATES

1.4.1 Indoor Air Quality Certifications

1.4.1.1 Roller Window Shades

Provide products certified to meet indoor air quality requirements by
UL 2818 (Greenguard)Gold, SCS Global Services Indoor Advantage Gold or

provide validation by other third-party program that products meet the requirements of this paragraph. Provide current product certification documentation from certification body.

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

1.5.1.1 Manufacturer's Qualifications

Obtain motor-controlled roller shades through one source from a single manufacturer with a minimum of twenty years experience and minimum of three projects of similar scope and size in manufacturing products comparable to those specified in this section.

1.5.1.2 Installer's Qualifications

Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.

1.5.2 Flammability Requirements

Passes in accordance with NFPA 701 small and large-scale vertical burn. Materials tested must be identical to products specified for use.

1.5.3 Electrical Requirements

NFPA Article 100 listed and labeled in accordance with UL 325 or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will not be acceptable in lieu of system testing.

1.5.4 Anti-Microbial Requirements

'No Growth' per ASTM G21 results for fungi ATCC9642, ATCC 9644, ATCC9645.

1.6 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.

1.7 WARRANTY

Provide 10 year minimum limited warranty.

PART 2 PRODUCTS

2.1 WINDOW SHADES

Roller tube must operate smoothly and be of sufficient diameter and thickness to prevent excessive deflection. Provide brackets that are appropriate for inside window mount. The shade cloth must meet the

performance described in NFPA 701, small scale test. Treat steel features for corrosion resistance.

Provide Various Fiber Components with a minimum of 60 percent recycled content. Provide data identifying percentage of recycled content for various fiber components.

Provide certification of indoor air quality for roller window shades.

2.1.1.1 Single Roller Shades

Shade fabric must be 100 percent non-pvc wrap knit polyester shade fabric that contains a minimum of 78 percent fibers made from recycled content. Provide 5% openness light filtering window shades to conform with the following:

- a. Roller tube must be extruded aluminum or steel. Diameter, wall thickness, and material must be selected by the manufacturer to accommodate the shade size. Provide roller idler assembly of molded nylon and zinc-plated steel pin. Sliding pin must allow easy installation and removal of roller. Fabric must be connected to the roller tube with double sided adhesive specifically developed to attach coated textiles to metal to eliminate horizontal impressions in fabric or attached with a spline lock system.
- b. Fascia must be L-shaped aluminum extrusion to conceal shade roller and hardware that snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands.
- c. End caps must be stamped steel with universal design suitable for mounting to window mullions. Provide size compatible with roller size. End cap covers must match fascia/headbox finish.
- d. Provide hardware that allows for field adjustment or removal of shade roller tube and other operable hardware component without requiring removal of brackets and end or center supports. Provide hardware system that allows for operation of multiple shade bands by a single operator. Connectors must be offset to assure alignment from the first to the last shade band. Provide shade hardware constructed of minimum 1/8 inch thick plated steel or heavier as required to support 150 percent of the full weight of each shade.
- e. Manual Operated Chain Drive Hardware must provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset must be adjustable for future change. Provide positive mechanical engagement of drive mechanism to shade roller tube. The drive bracket must be fully integrated with all accessories. Drive chain must be #10 stainless steel chain rated to 90 lb. minimum breaking strength.

2.1.1.2 Double Roller Shades

Provide standard mounting that is compatible with dual fascia or dual pocket headboxes. Provide (1) roll with 5% openness light filtering fabric and (1) room darkening (black-out) fabric to eliminate all visible light gaps when shades are fully closed, and conform with the following:

- a. Roller tube must be aluminum, controlled by webbing tape. Provide shop fabricated light traps, consisting of a head box to house the shade roller, and U-shaped channels to serve as guides for the shade along the sides and to receive the bottom edge of the shade along the sill.
- b. Provide light trap made of sheet steel having a minimum thickness of 22 gauge or anodized, extruded, aluminum. The legs of the channels must be not less than 1-3/4 inches long and separated by the minimum distance that will permit free operation of the shade. Edges of light trap coming into contact with the shade cloth must be smooth pile light seal. The exposed face of the head box must be hinged or removable for access to the shade roller. The interior or unexposed surfaces of the light trap must have a finish coat of flat black enamel. The exposed portions of the light trap must have a factory-applied priming coat of gray paint.
- c. Cloth must be of type for blackout purposes. Make the shade from a single piece of canvas duck cloth laminated to vinyl. When not finished with a selvage, the vertical edges of the shade must be bound or hemmed using a high-grade thread. Make needle holes lightproof by applying a suitable filler.
- d. Fit the bottom edge of the shade with a steel operating bar. Shades will engage positively with bottom rail through chain pull. Paint bars with flat black enamel. Make pull cords of No. 4 braided nylon or beaded chain having not less than 175 pounds breaking strength.

2.2 COLOR

Provide color, pattern and texture for metal and shade fabric as indicated on the drawings. Fascia/headbox finish must be brushed satin metal finish. Color listed is not intended to limit the selection of equal colors from other manufacturers.

PART 3 EXECUTION

3.1 FIELD MEASUREMENTS

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 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Perform installation in accordance with the approved detail drawings and manufacturer's installation instructions. Install units level, plumb, secure, and at proper height and location relative to window units. Install roller window shades on interior wall directly above top of window opening. Install fascia and headbox to completely cover hardware. Provide and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Do not start installation until completion of room painting and finishing operations.

3.3 CLEAN-UP

Upon completion of the installation, clean window treatments 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 shades installed in recessed pockets can be removed without disturbing the pocket. The entire shade, when retracted, must be contained inside the pocket. For shades 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 --

Volume 2 of 2
Division 21 - 33

CONTRACT N40085-22-F-6938

NAVFAC SPECIFICATION

RR1 REPAIR BY REPLACEMENT
PROJECT # P1594

AT THE

MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

DESIGN BY:

Public Works Design Division
Camp Lejeune, NC

OR

MBF ARCHITECTS, PA
NEW BERN, NORTH CAROLINA

A/E Contract: N40085-22-D-0002

SPECIFICATION PREPARED BY:

Darden J. Eure, III
MBF Architects, PA

Date: 27 April 2023



27 April 2023

SPECIFICATION APPROVED BY:

, Director
Design Branch, Public Works Division

, Commander, CEC, U.S. Navy
for Commander, Naval Facilities Engineering Command

This page is intentionally left blank.

DIVISION 21 - FIRE SUPPRESSION

DIVISION 22 - PLUMBING

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

DIVISION 25 - INTEGRATED AUTOMATION

DIVISION 26 - ELECTRICAL

DIVISION 27 - COMMUNICATIONS

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

PROJECT TABLE OF CONTENTS Page 1

DIVISION 31 - EARTHWORK

31 11 00	11/18	CLEARING AND GRUBBING
31 23 00.00 20	02/11, CHG 2: 08/15	EXCAVATION AND FILL
31 31 16.13	08/22	CHEMICAL TERMITE CONTROL

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 11 23	05/22	AGGREGATE BASE COURSE
32 11 26	05/20	HOT-MIX BITUMINOUS BASE COURSE FOR ROADS AND STREETS
32 17 23	08/16, CHG 5: 11/18	PAVEMENT MARKINGS
32 31 13.53	11/21	HIGH-SECURITY FENCES (ORNAMENTAL) AND GATES
32 92 23	04/06, CHG 1: 08/21	SODDING

DIVISION 33 - UTILITIES

33 11 00	02/18, CHG 1: 02/22	WATER UTILITY DISTRIBUTION PIPING
33 30 00	05/18	SANITARY SEWERAGE
33 40 00	11/21	STORMWATER UTILITIES
33 71 01	05/19, CHG 1: 11/19	OVERHEAD TRANSMISSION AND DISTRIBUTION
33 71 02	08/21	UNDERGROUND ELECTRICAL DISTRIBUTION
33 82 00	08/22	TELECOMMUNICATIONS OUTSIDE PLANT (OSP)

-- End of Project Table of Contents --

SECTION 21 13 13

WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION
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 SOCIETY OF MECHANICAL ENGINEERS (ASME)

- | | |
|-------------|---|
| 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 B16.4 | (2021) Gray Iron Threaded Fittings; Classes 125 and 250 |
| ASME B16.21 | (2021) Nonmetallic Flat Gaskets for Pipe Flanges |

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

- | | |
|-----------|---|
| ASSE 1013 | (2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies |
| ASSE 1015 | (2021) Performance Requirements for Double Check Backflow Prevention Assemblies |

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 | (2021) Ductile-Iron and Gray-Iron Fittings |
| AWWA C111/A21.11 | (2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C203 | (2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied |
| AWWA M14 | (2015) Manual: Recommended Practice for Backflow Prevention and Cross-Connection Control |

ASTM INTERNATIONAL (ASTM)

- | | |
|---------------|---|
| ASTM A47/A47M | (1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron |
|---------------|---|

Castings

ASTM A53/A53M (2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A135/A135M (2021) Standard Specification for Electric-Resistance-Welded Steel Pipe

ASTM A153/A153M (2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A183 (2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts

ASTM A536 (1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings

FM GLOBAL (FM)

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 (2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13 (2022; ERTA 1 2021) Standard for the Installation of Sprinkler Systems

NFPA 24 (2022) Standard for the Installation of Private Fire Service Mains and Their Appurtenances

NFPA 291 (2022) Recommended Practice for Fire Flow Testing and Marking of Hydrants

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

UNDERWRITERS LABORATORIES (UL)

UL 199 (2020) UL Standard for Safety Automatic Sprinklers for Fire-Protection Service

UL 312 (2022) UL Standard for Safety Check Valves for Fire-Protection Service

UL 405	(2013; Bul. 2020) UL Standard for Safety Fire Department Connection Devices
UL 668	(2004; Reprint Oct 2021) UL Standard for Safety Hose Valves for Fire-Protection Service
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 SYSTEM DESCRIPTION

Provide wet pipe sprinkler system(s) in all areas of the building. Except as modified herein, the system must meet the requirements of NFPA 13. Pipe sizes which are not indicated on the Contract drawings must be determined by hydraulic calculations.

1.2.1 Hydraulic Design

1.2.1.1 Basis for Calculations

A waterflow test was performed on 12 October 2022 on site and resulted in a static pressure of 76 psi with a residual pressure of 60 psi while flowing 1,130 gpm. Perform a fire hydrant flow test prior to shop drawing submittal in accordance with NFPA 291. Results must include hydrant elevations relative to the building and hydrant number/identifiers for the tested hydrants, including which were flowed, which had a gauge. This information must be presented in a tabular form if multiple hydrants were flowed. The results must be included with the hydraulic calculations. Hydraulic calculations must be based on flow test noted in this paragraph, unless approved by Contracting Officer. Hydraulic calculations must be based upon the Hazen-Williams formula with a "C" value noted in NFPA 13 for piping. The minimum residual pressure in a service lateral (lead-in) at the design flow rate must be 20 psi at the inlet to the backflow preventer.

1.2.1.2 Hydraulic Calculations

- a. Water supply curves and system requirements must be plotted on semi-logarithmic graph ($N^{1.85}$) paper so as to present a summary of the complete hydraulic calculation.
- b. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, minimum discharge pressures and minimum flows. Elevations of hydraulic reference points (nodes) must be indicated.
- c. Documentation must 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.
- d. Where the sprinkler system is supplied by interconnected risers, the sprinkler system must be hydraulically calculated using the hydraulically most demanding single riser. The calculations must not assume the simultaneous use of more than one riser.
- e. All calculations must include the backflow preventer manufacturer's stated friction loss at the design flow or 12 psi for reduced pressure

backflow preventer, whichever is greater.

- f. All calculations must be performed back to the actual location of the flow test, taking into account the direction of flow in the service main at the test location.
- g. For gridded systems, calculations must show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. A flow diagram indicating the quantity and direction of flows must be included.

1.2.1.3 Design Criteria

Hydraulically design the system to discharge a minimum density as indicated on the drawings. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13. Add an allowance for exterior hose streams as shown on the drawings to the sprinkler system demand at the point of connection to the existing water system.

1.2.2 Sprinkler Coverage

Sprinklers must be uniformly spaced on branch lines. Provide coverage throughout 100 percent of the building. This includes, but is not limited to, telephone rooms, electrical equipment rooms (regardless of the fire resistance rating of the enclosure), boiler rooms, switchgear rooms, transformer rooms, attached electrical vaults and other electrical and mechanical spaces. Coverage per sprinkler must be in accordance with NFPA 13. Provide sprinklers below all obstructions in accordance with NFPA 13.

1.2.3 Qualified Fire Protection Engineer (QFPE)

An individual who is a licensed professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Services of the QFPE must include:

- a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Working (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.
- b. Provide a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting all outstanding comments.
- c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).
- d. Witnessing pre-Government and final Government functional performance testing and performing a final installation review.
- e. Signing applicable certificates under SD-07.

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 Contractor Quality Control approval. Partial submittals and submittals not fully complying with NFPA 13 and this specification section must be returned disapproved without review. SD-02, SD-03 and SD-05 must be submitted simultaneously.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE must be returned disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G

Sprinkler System Designer; G

Sprinkler System Installer; G

SD-02 Shop Drawings

Shop Drawing; G

SD-03 Product Data

Pipe; G

Fittings; G

Valves, including gate, check, butterfly, and globe; G

Relief Valves; G

Sprinklers ; G

Pipe Hangers and Supports ; G

Sprinkler Alarm Switch; G

Valve Supervisory (Tamper) Switch; G

Fire Department Connection; G

Backflow Prevention Assembly; G

Air Vent; G

Hose Valve; G

Nameplates; G

SD-05 Design Data

Hydraulic Calculations; G

SD-06 Test Reports

Test Procedures; G

SD-07 Certificates

Verification of Compliant Installation; G

Request for Government Final Test; G

SD-10 Operation and Maintenance Data

Operating and Maintenance (O&M) Instructions; G

Spare Parts Data; G

SD-11 Closeout Submittals

As-built drawings

1.4 QUALITY ASSURANCE

1.4.1 Preconstruction Submittals

Within 36 days of contract award but no less than 14 days prior to commencing work on site, the prime Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications will be returned Disapproved Without Review.

1.4.1.1 Shop Drawing

Three copies of the shop drawings, no later than 28 days prior to the start of system installation. Working drawings conforming to the requirements prescribed in NFPA 13 and must be no smaller than the Contract Drawings. Each set of drawings must include the following:

- a. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.
- b. Floor plans drawn to a scale not less than 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, and other details required to clearly describe the proposed arrangement.
- 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 must 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, elevation of each typical sprinkler above finished floor and elevation of "cloud" or false ceilings in relation to the building ceilings.
- e. Plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance.
- f. Riser layout drawings drawn to a scale of not less than 1/2-inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.
- g. Details of each type of riser assembly, pipe hanger, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. The dimension from the edge of vertical piping to the nearest adjacent wall(s) must be indicated on the drawings when vertical piping is located in stairs or other portions of the means of egress.
- h. Details of each type of pipe hanger and related components.

1.4.1.2 Product Data

Three copies of annotated catalog data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, options, and other pertinent information, that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

1.4.1.3 Hydraulic Calculations

Calculations must be as outlined in NFPA 13 except that calculations must be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Calculations must include isometric diagram indicating hydraulic nodes and pipe segments.

1.4.1.4 Operating and Maintenance (O&M) Instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA as supplemented and modified by this specification section.

Provide six manuals and one pdf version on electronic media. The manuals must 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, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment.

Submit spare parts data for each different item of material and equipment specified. The data must include a complete list of parts and supplies, 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.

1.4.2 Qualifications

1.4.2.1 Sprinkler System Designer

The sprinkler system designer must be certified as a Level III Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with [NICET 1014-7](#).

1.4.2.2 Sprinkler System Installer

The sprinkler system installer must be regularly engaged in the installation of the type and complexity of system specified in the contract documents, and must 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.

1.4.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as [UL Fire Prot Dir](#) or [FM APP GUIDE](#). The omission of these terms under the description of an item or equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation are mandatory requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. All pipes must be either capped or plugged until installed.

1.6 EXTRA MATERIALS

Spare sprinklers and wrench(es) must be provided as [spare parts](#) in accordance with [NFPA 13](#).

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials, equipment, and devices listed for fire protection service when so required by [NFPA 13](#) or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for a classification of material. Material and equipment must be standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid.

2.1.2 Nameplates

Major components of equipment must 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 name plate permanently affixed to the item or

equipment. Nameplates must be etched metal or plastic, permanently attached by screws to control units, panels or adjacent walls.

2.1.3 Identification and Marking

Pipe and fitting markings must include name or identifying symbol of manufacturer and nominal size. Pipe must be marked with ASTM designation. Valves and equipment markings must have name or identifying symbol of manufacturer, specific model number, nominal size, name of device, arrow indicating direction of flow, and position of installation (horizontal or vertical), except if valve can be installed in either position. Markings must be included on the body casting or on an etched or stamped metal nameplate permanently on the valve or cover plate.

2.1.4 Pressure Ratings

Valves, fittings, couplings, alarm switches, and similar devices must be rated for the maximum working pressures that can be experienced in the system, but in no case less than 175 psi.

2.2 UNDERGROUND PIPING COMPONENTS

2.2.1 Pipe

Pipe must comply with NFPA 24. Minimum pipe size is 6 inches. Piping more than 5 feet outside the building walls must comply with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING. A continuous section of welded stainless steel fire water service piping from a point outside the building perimeter to a flanged fitting at least 1-foot above the finished floor within the building is acceptable.

2.2.2 Fittings and Gaskets

Fittings must be ductile-iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets must be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile-iron pipe joints must conform to AWWA C111/A21.11.

2.2.3 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape, 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold block letters continuously and repeatedly over the entire tape length. Warning and identification must read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.3 ABOVEGROUND PIPING COMPONENTS

2.3.1 Steel Piping Components

2.3.1.1 Steel Pipe

Except as modified herein, steel pipe must be black as permitted by NFPA 13 and conform to the applicable provisions of ASTM A53/A53M, ASTM A135/A135M or ASTM A153/A153M.

Steel pipe must be minimum Schedule 40 for sizes 2 inches and less; and minimum Schedule 10 for sizes larger than 2 inches. Steel piping with wall thickness less than Schedule 40 must not be threaded. Grooved pipe must be cut-grooved.

2.3.1.2 Fittings

Fittings must be welded, threaded, or grooved-end type. Threaded fittings must be cast-iron conforming to ASME B16.4, malleable-iron conforming to ASME B16.3 or ductile-iron conforming to ASTM A536. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe, steel press fittings and field welded fittings are not permitted. Fittings, mechanical couplings, and rubber gaskets must be supplied by the same manufacturer. Threaded fittings must use Teflon tape or manufacturer's approved joint compound. Reducing couplings are not permitted except as allowed by NFPA 13.

2.3.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings must be designed for not less than 175 psi service and the product of the same manufacturer. Field welded fittings must not be used. Fitting and coupling housing must be malleable-iron conforming to ASTM A47/A47M, Grade 32510; ductile-iron conforming to ASTM A536, Grade 65-45-12. Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 2 inches and larger. Gasket must be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts must be heat-treated steel conforming to ASTM A183 and must be cadmium-plated or zinc-electroplated.

2.3.1.4 Flanges

Flanges must conform to NFPA 13 and ASME B16.1. Gaskets must be non-asbestos compressed material in accordance with ASME B16.21, 1/16-inch thick, and full face or self-centering flat ring type.

2.3.2 Flexible Sprinkler Hose

The use of flexible hose is not permitted.

2.3.3 Pipe Hangers and Supports

Provide galvanized pipe hangers and supports in accordance with NFPA 13.

2.3.4 Valves

Provide valves of types approved for fire service. Valves must open by counterclockwise rotation.

2.3.4.1 Control Valve

Manually operated sprinkler control/gate valve must be outside stem and yoke (OS&Y) type or butterfly type and must be listed.

2.3.4.2 Check Valves

Check valves must comply with UL 312. Check valves 4 inches and larger must be of the swing type, have a clear waterway and meet the requirements of MSS SP-71, for Type 3 or 4. Inspection plate must be provided on

valves larger than 6 inches.

2.3.5 Riser Check Valves

Provide riser check valve, pressure gauges and main drain.

2.4 ALARM INITIATING AND SUPERVISORY DEVICES

2.4.1 Sprinkler Alarm Switch

Vane or pressure-type flow switch(es). Vane type alarm actuating devices must have mechanical diaphragm controlled retard device adjustable from 10 to 60 seconds and must instantly recycle.

2.4.2 Valve Supervisory (Tamper) Switch

Switch must be integral to the control valve or suitable for mounting to the type of control valve to be supervised open. The switch must be tamper resistant and contain 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.

2.5 BACKFLOW PREVENTION ASSEMBLY

Reduced-pressure principle valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve must have a drain. Backflow prevention assemblies must have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of the specific make, model, design, and size in the FCCCHR List is acceptable as the required documentation.

2.5.1 Backflow Preventer Test Connection

Test connection must consist of a series of listed hose valves with 2 1/2-inch National Standard male hose threads with cap and chain.

2.6 FIRE DEPARTMENT CONNECTION

Fire department connection must be projecting type with cast-brass body, matching escutcheon lettered "Auto Spkr" with a polished-brass finish. The connection must have individual self-closing clappers, cap with drip drain and chain. Female inlets must have 5-inch diameter Storz connection on a 30 degree galvanized elbow downward facing (non-swivel). Comply with UL 405.

2.7 SPRINKLERS

Sprinklers must comply with UL 199 and NFPA 13. Sprinklers with internal O-rings are not acceptable. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters must have temperature classification in accordance with NFPA 13. Extended coverage sprinklers are permitted for loading docks, residential occupancies and high-piled storage applications only.

2.7.1 Upright Sprinkler

Upright sprinkler must be brass quick-response type and have a minimum nominal K-factor of 5.6.

2.7.2 Concealed Sprinkler

Concealed sprinkler must be chrome-plated quick-response type and have a minimum nominal K-factor of 5.6. Coverplate must be white.

2.7.3 Corrosion-Resistant Sprinkler

Corrosion-resistant sprinkler must be the concealed pendent type installed in locations as indicated. Corrosion-resistant coatings must be factory-applied by the sprinkler manufacturer.

2.7.4 Dry Sprinkler Assembly

Dry sprinkler assembly must be of the sidewall type as indicated. Assembly must include an integral escutcheon. Maximum length must not exceed maximum indicated in its listing. Sprinkler must have a polished chrome finish.

2.8 ACCESSORIES

2.8.1 Sprinkler Cabinet

Provide spare sprinklers in accordance with NFPA 13 and must be placed in a suitable metal or plastic cabinet of sufficient size to accommodate all the spare sprinklers and wrenches in designated locations. Spare sprinklers must be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed as required by NFPA 13. At least one wrench of each type required must be provided.

2.8.2 Pendent Sprinkler Escutcheon

Escutcheon must be one-piece metallic type with a depth of less than 3/4-inch and suitable for installation on pendent sprinklers. The escutcheon must have a factory finish that matches the pendent sprinkler.

2.8.3 Pipe Escutcheon

Provide split hinge metal plates for piping entering walls, floors, and ceilings in exposed spaces. 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.

2.8.4 Sprinkler Guard

Listed guard must be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards must be provided on sprinklers located within 7 feet of the floor.

2.8.5 Relief Valve

Relief valves must be listed and installed at the riser in accordance with NFPA 13.

2.8.6 Air Vent

Air vents must be of the automatic type and piped to drain to the building exterior.

2.8.7 Identification Sign

Valve identification sign must be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gage steel or 0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign must 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. Where there is more than one sprinkler system, signage must include specific details as to the respective system.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work that is dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative a condition that prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

The installation must be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein. Locate sprinklers in a consistent pattern with ceiling grid, lights, and air supply diffusers. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

- a. Piping offsets, fittings, and other accessories required must be furnished to provide a complete installation and to eliminate interference with other construction.
- b. Wherever the contractor's work interconnects with work of other trades the Contractor must coordinate with other Contractors to insure all Contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers and similar equipment) that are concealed above hung ceilings by permanent color coded pins/tabs in the ceiling directly below the item.
- c. Provide required supports and hangers for piping, conduit, and equipment so that loading will not exceed allowable loadings of structure. Submittal of a bid must be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

3.2.1 Waste Removal

At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash which may have accumulated during the day as a result of work by the contractor and of his presence on the job. Sidewalks and streets adjoining the property must be kept broom clean and free of waste, debris, trash and obstructions caused by work of the contractor, which will affect the condition and safety of streets, walks,

utilities, and property.

3.3 UNDERGROUND PIPING INSTALLATION

The fire protection water main must be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover must be 3 feet or the frost line, whichever is deeper. The supply line must terminate inside the building with a flanged piece, the bottom of which must be set not less than 1-foot above the finished floor. A blind flange must be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block must be provided at the elbow where the pipe turns up toward the floor. In addition, joints must be anchored in accordance with NFPA 24. Buried steel components must be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls must meet the requirements of Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.4 ABOVEGROUND PIPING INSTALLATION

The methods of fabrication and installation of the aboveground piping must fully comply with the requirements and recommended practices of NFPA 13 and this specification section.

3.4.1 Protection of Piping Against Earthquake Damage

Seismic restraint is not required.

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, must 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 must be concealed above ceilings. Piping must be inspected, hydrostatically tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas must be concealed.

3.4.4 Concealed Sprinklers

- a. Drop nipples to pendent sprinklers must consist of minimum 1-inch pipe with a reducing coupling into which the sprinkler must be threaded.
- b. Where sprinklers are installed below suspended or dropped ceilings, drop nipples must be cut such that sprinkler ceiling plates are of a uniform depth throughout the finished space. The outlet of the reducing coupling must not extend below the underside of the ceiling.
- c. Concealed sprinklers in suspended ceilings must be located in the center of the tile (plus or minus 2 inches).

3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers must contain no fittings between the branch line tee and the reducing coupling at the sprinkler.

3.4.6 Pipe Joints

Pipe joints must conform to NFPA 13, except as modified herein. Not more than four threads must 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 must be provided where indicated or required by NFPA 13. Grooved pipe and fittings must 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 must be products of the same manufacturer. For copper tubing, pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must 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 must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.4.7 Reducers

Reductions in pipe sizes must be made with one-piece tapered reducing fittings. When standard fittings of the required size are not manufactured, single bushings of the face or hex type will be permitted. Where used, face bushings must be installed with the outer face flush with the face of the fitting opening being reduced. Bushings cannot 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

- a. 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 must be core-drilled and provided with pipe sleeves. Each sleeve must be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe and extend through its respective wall or floor and be cut flush with each wall surface. Sleeves must provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe must be firmly packed with mineral wool insulation.
- b. Where pipes and sleeves penetrate fire walls, fire partitions, or floors, pipes/sleeves must be firestopped in accordance with Section 07 84 00 FIRESTOPPING.
- c. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe must 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 must be provided for pipe penetration in finished areas of

ceilings, floors and walls. Escutcheons must be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

Unless otherwise indicated, the test connection must consist of 1-inch pipe connected at the riser as a combination test and drain valve; 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". All test connection piping must be inside of the building and penetrate the exterior wall at the location of the discharge orifice only. The discharge orifice must be located outside the building wall no more than 2 feet above finished grade, terminated at a hard surface or concrete splash block to prevent erosion. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building. Do not discharge to the roof. Discharge to floor drains, janitor sinks or similar fixtures is not permitted.

Provide concrete splash blocks at all drain and inspector's test connection discharge locations if not discharging to a concrete surface. Splash blocks must be large enough to mitigate erosion and not become dislodged during a full flow of the drain. Ensure all discharged water drains away from the facility and does not cause property damage.

3.4.11 Backflow Preventer

Locate within the building or in a heated enclosure in locations subject to freezing. For heated enclosures, provide a low temperature supervisory alarm connected to the facility fire alarm system. Heat trace is not permitted to be used.

Install backflow preventers so that the bottom of the assembly is a minimum of 6 inches above the finished floor/grade. Install horizontal backflow preventers so that the bottom of the assembly is no greater than 24 inches above the finished floor/grade. Install vertical backflow preventers so that the upper operating handwheel is no more than 6 feet above the finished floor/grade. Clearance around control valve handles must be minimum 6 inches above grade/finished floor and away from walls.

3.4.11.1 Test Connection

Provide downstream of the backflow prevention assembly UL 668 hose valves with 2.5-inch National Standard male hose threads with cap and chain. Provide one valve for each 250 gpm of system demand or fraction thereof. Provide a permanent sign in accordance with paragraph entitled "Identification Signs" which reads, "Test Valve". Indicate location of test header. If an exterior connection, provide a control valve inside a heated mechanical room to prevent freezing.

3.4.12 Drains

- a. Main drain piping must be provided to discharge at a safe point outside the building, no more than 2 feet above finished grade. Terminate at a hard surface or a concrete splash block. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building.

- b. Auxiliary drains must be provided as required by NFPA 13. Auxiliary drains are permitted to discharge to a floor drain if the drain is sized to accommodate full flow (min 40 gpm). Discharge to service sinks or similar plumbing fixtures is not permitted.

3.4.13 Installation of Fire Department Connection

Connection must be mounted on the exterior wall approximately 3 feet above finished grade. The piping between the connection and the check valve must be provided with an automatic drip in accordance with NFPA 13 and piped to drain to the outside.

3.4.14 Identification Signs

Signs must 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. Main drain test results must be etched into main drain identification sign. Hydraulic design data must be etched into the nameplates and permanently affixed to each sprinkler riser as specified in NFPA 13. Provide labeling on the surfaces of all feed and cross mains to show the pipe function (e.g., "Sprinkler System", "Fire Department Connection", "Standpipe") and normal valve position (e.g. "Normally Open", "Normally Closed"). For pipe sizes 4-inch and larger provide white painted stenciled letters and arrows, a minimum of 2 inches in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 4-inch, provide white painted stenciled letters and arrows, a minimum of 0.75-inch in height and visible from the floor.

3.4.15 Sprinkler Gauge

Install sprinkler gauge installation labels on each sprinkler gauge. Label must indicate date installed and test or replace date.

3.5 ELECTRICAL

Except as modified herein, electric equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Alarm signal wiring connected to the building fire alarm control system must be by the fire alarm installer.

3.6 PAINTING

Color code mark piping red.

3.7 FIELD QUALITY CONTROL

3.7.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level III Fire Sprinkler Technician, and the representative of the installing company, and reviewed by the QFPE 60 days prior to performing system tests. Detailed test procedures must list all components of the installed system. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 13). The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government final testing.

- a. 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.

3.7.2 Pre-Government Testing

3.7.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that equipment is functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" and "System Acceptance" as noted in NFPA 13. The Contractor and QFPE must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 13 and the test reports noted below.

- a. NFPA 13 Aboveground Material and Test Certificate
- b. NFPA 13 Underground Material and Test Certificate

3.7.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the Designated Fire Protection Engineer (DFPE). Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation fire alarm reporting system have been completed and tested to confirm communications are fully functional. Submit request for test at least 15 calendar days prior to the requested test date.

3.7.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.7.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

- a. The manufacturer's technical representative.
- b. The contractor's Qualified Fire Protection Engineer (QFPE).
- c. Marked-up red line drawings of the system as actually installed.

Government Final Tests will be witnessed by the Designated Fire Protection Engineer, and Qualified Fire Protection Engineer (QFPE). At this time,

all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.8 MINIMUM SYSTEM TESTS

The system, including the underground water mains, and the aboveground piping and system components, must be tested to ensure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure must be tested in accordance with NFPA 13 and NFPA 24.

3.8.1 Underground Piping

3.8.1.1 Flushing

Underground piping must be flushed at a minimum of 10 fps in accordance with NFPA 24.

3.8.1.2 Hydrostatic Test

New underground piping must be hydrostatically tested in accordance with NFPA 24.

3.8.2 Aboveground Piping

3.8.2.1 Hydrostatic Test

Aboveground piping must be hydrostatically tested in accordance with NFPA 13. There must be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure must 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 must be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor must provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5-inch diameter hoses, playpipe nozzles or flow diffusers, calibrated pressure gauges, and pitot tube gauge. The Contractor must provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction loss) across the assembly must be recorded. A metal placard must be provided 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 determined during the preliminary testing. The pressure drop must be compared to the manufacturer's data and the readings observed during the final inspections and tests.

3.8.3 Main Drain Flow Test

Following flushing of the underground piping, a main drain test must be made to verify the adequacy of the water supply. Static and residual pressures must be recorded on the certificate specified in paragraph SUBMITTALS.

3.9 SYSTEM ACCEPTANCE

Following acceptance of the system, [as-built drawings](#) and O&M manuals must be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the final acceptance test.

- a. The drawings must be prepared electronically and sized no less than the contract drawings. Furnish one set of [PDFs and](#) CDs or DVDs containing software back-up and CAD based drawings in latest version of AutoCADDXF and portable document formats of as-built drawings and schematics.
- b. Provide [operating and maintenance \(O&M\) instructions](#).

3.10 ONSITE TRAINING

Conduct a training course for the responding fire department and operating and maintenance personnel as designated by the Contracting Officer. Training must be performed on two separate days (to accommodate different shifts of Fire Department personnel) for a period of 4 hours of normal working time and must start after the system is functionally complete and after the final acceptance test. The on-site training must cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

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 Z21.10.1/CSA 4.1 (2017) Gas Water Heaters Vol. I, Storage
Water Heaters with Input Ratings of 75,000
Btu Per Hour or Less

ANSI Z21.10.3/CSA 4.3 (2019) Gas-Fired Water Heaters Vol.III,
Storage Water Heaters With Input Ratings
Above 75,000 Btu Per Hour, Circulating and
Instantaneous

ANSI Z21.22/CSA 4.4 (2015; R 2020) Relief Valves for Hot Water
Supply Systems

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 A112.6.1M (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 A112.19.2/CSA B45.1 (2018; ERTA 2018) Standard for Vitreous
China Plumbing Fixtures and Hydraulic
Requirements for Water Closets and Urinals

ASME A112.36.2M (1991; R 2017) Cleanouts

ASME B1.20.1 (2013; R 2018) Pipe Threads, General
Purpose (Inch)

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 B16.22	(2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.50	(2013) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
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

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2016) Performance Requirements for Atmospheric Type Vacuum Breakers
ASSE 1010	(2004) Performance Requirements for Water Hammer Arresters (ANSI approved 2004)
ASSE 1011	(2004; Errata 2004) Performance Requirements for Hose Connection Vacuum Breakers (ANSI approved 2004)
ASSE 1012	(2009) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent - (ANSI approved 2009)
ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1018	(2001) 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
ASSE 1037	(2015; Reprint Sep 2017) Performance Requirements for Pressurized Flushing Devices for Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
------------	---

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 C651	(2014) Standard for Disinfecting Water Mains
AWWA C652	(2011) Disinfection of Water-Storage Facilities

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 B32	(2020) Standard Specification for Solder Metal
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2018) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
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 C564	(2014) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2665	(2014) Standard Specification for

Poly(Vinyl Chloride) (PVC) Plastic Drain,
Waste, and Vent Pipe and Fittings

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 D3139

(2019) Joints for Plastic Pressure Pipes
Using Flexible Elastomeric Seals

ASTM D3212

(2020) Standard Specification for Joints
for Drain and Sewer Plastic Pipes Using
Flexible Elastomeric Seals

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 F477

(2014; R 2021) Standard Specification for
Elastomeric Seals (Gaskets) for Joining
Plastic Pipe

ASTM F891

(2016) Standard Specification for
Coextruded Poly (Vinyl Chloride) (PVC)
Plastic Pipe with a Cellular Core

ASTM F1760

(2016) Standard Specification for
Coextruded Poly(Vinyl Chloride) (PVC)
Non-Pressure Plastic Pipe Having
Reprocessed-Recycled Content

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015

(2016; 14/17) Copper Tube Handbook

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1 COMM

(2017) Standard And Commentary Accessible
and Usable Buildings and Facilities

ICC IPC

(2018) International Plumbing Code

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-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 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 54	(2021) National Fuel Gas Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF 372	(2016) Drinking Water System Components - Lead Content
NSF/ANSI 14	(2021) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2022) Drinking Water System Components - Health Effects

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA Fire Man	(2016) Firestopping: Plastic Pipe in Fire Resistive Construction
---------------	---

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. DEPARTMENT OF ENERGY (DOE)

Energy Star

(1992; R 2006) Energy Star Energy
Efficiency Labeling System (FEMP)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

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 1951

(2011; Reprint Aug 2017) UL Standard for
Safety Electric Plumbing Accessories

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-03 Product Data

Fixtures

List of installed fixtures with manufacturer, model, and flow rate.

Flush Valve Water Closets

WaterSense Label for Flush Valve Water Closet; S

Flush Valve Urinals

WaterSense Label for Urinal; S

Wall Hung Lavatories

Precast Terrazzo Mop Sinks

Energy Star Label for Wheelchair Electric Water Cooler; S

Water Heaters; G

Pumps; G

SD-06 Test Reports

Tests, Flushing and Disinfection

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.

Materials and Equipment

SD-10 Operation and Maintenance Data

Plumbing System; G,

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

1.6 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. 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. Material or equipment containing a weighted average of greater than 0.25 percent 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. 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.

2.1.1 Pipe Joint Materials

Solder containing lead shall not be used with copper pipe. Joints and gasket materials shall conform to the following:

- a. **Brazing Material:** Brazing material shall conform to AWS A5.8/A5.8M, BCuP-5.
- b. **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.

- c. Solder Material: Solder metal shall conform to ASTM B32.
- d. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B813, Standard Test 1.
- e. Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477.
- f. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D2564 and ASTM D2855.
- g. Copper tubing shall conform to ASTM B88, Type K, L or M.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

- a. Water Hammer Arrestor: PDI WH 201. Water hammer arrester shall be diaphragm 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. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.
- i. Hypochlorites: AWWA B300.
- j. Liquid Chlorine: AWWA B301.

k. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element:
ASME B40.100.

l. 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
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 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

2.3.1 Wall Faucets

Wall faucets 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.

2.3.2 Wall Hydrants (Frostproof)

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 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. Relief valves for systems where the maximum rate of heat input is greater than 200,000 Btuh shall have 1 inch minimum inlets, and 1 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

2.3.4 Thermostatic Mixing Valves

Provide thermostatic mixing valve for lavatory faucets. 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

Water closet replacements in major renovations may have a flush valve of up to 1.6 GPF to accommodate existing plumbing capacity. Fixtures for use by the physically handicapped shall be in accordance with ICC A117.1 COMM. 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 shall be copper alloy with all visible surfaces chrome plated.

2.4.1 Automatic Controls

Provide automatic, sensor operated faucets and flush valves to comply with ASSE 1037 and UL 1951 for lavatory faucets, urinals, and water closets. Flushing and faucet systems shall consist of solenoid-activated valves with light beam sensors. Flush valve for water closet shall include an override pushbutton. 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. Provide a dual-flush water

closet and flush valve combination that will also provide a second flushing water volume not to 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 electrical-operated light-beam-sensor to energize the solenoid.

2.4.4.3 Flush Valve Urinals

ASME A112.19.2/CSA B45.1, white vitreous china, ,wall-mounted, wall outlet, siphon jet, integral trap, and extended side shields. Provide urinal with the rim 17 inches above the floor. Provide urinal with the rim 24 inches above the floor. Water flushing volume of the urinal and flush valve combination shall not exceed 0.125 gallons per flush. Urinals must meet the specifications of http://www.epa.gov/watersense/partners/product_program_specs.html and must be EPA WaterSense labeled products. Provide data identifying WaterSense label for urinal. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports. 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. Provide solenoid-activated flush valves including electrical-operated light-beam-sensor to energize the solenoid.

2.4.4.4 Wall Hung Lavatories

ASME A112.19.2/CSA B45.1, white vitreous china, ,straight back type, minimum dimensions of 19 inches, wide by 17 inches front to rear, with supply openings for use with top mounted centerset faucets, and openings for concealed arm carrier installation. Provide aerator with faucet. Provide lavatory faucets and accessories meeting the flow rate and product requirements of the paragraph LAVATORIES. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports and concealed arms for the lavatory. Mount lavatory with the front rim 34 inches above floor and with 29 inches minimum clearance from bottom of the front rim to floor. Provide top-mounted solenoid-activated lavatory faucets including electrical-operated light-beam-sensor to energize the solenoid.

2.4.4.5 Wheelchair Drinking Water cooler

AHRI 1010, wall-mounted bubbler style with ASME A112.6.1M concealed chair carrier, air-cooled condensing unit, 4.75 gph minimum capacity, stainless steel splash receptor, and all stainless steel cabinet, with 27 inch minimum knee clearance from front bottom of unit to floor and 36 inch maximum spout height above floor and bottle filler. Bubblers shall also be controlled by push levers, by push bars, or touch pads one on each side or one on front and both sides of the cabinet. Provide filters for chlorine in supply piping to faucets. Provide electric water cooler that

is Energy Star labeled. Provide data identifying Energy Star label for wheelchair electric water cooler.

2.4.6 Precast Terrazzo Mop Sinks

Terrazzo shall be made of marble chips cast in white portland cement to produce 3000 psi minimum compressive strength 7 days after casting. Provide floor or wall outlet copper alloy body drain cast integral with terrazzo, with polished stainless steel strainers.

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 and Shower 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 drain with trap primer connection, trap primer, and connection piping. Primer shall meet ASSE 1018.

2.6.2 Area Drains

Area drains shall be plain pattern with polished stainless steel perforated or slotted grate and bottom outlet. The drain shall be circular or square with a 12 inch nominal overall width or diameter and 10 inch nominal overall depth. 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 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. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 90 to 160 degrees F. Each gas-fired water heater and booster water heater shall have controls with an adjustable range that includes 120 to 180 degrees F. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III in PART 3 of this Section for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 500 gallons storage capacity need not meet the standard loss requirement if the tank surface area is insulated to R-12.5 and if a standing light is not used. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. 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.

2.8.1 Automatic Storage Type

Heaters shall be complete with control system, temperature gauge, and pressure gauge, and shall have ASME rated combination pressure and temperature relief valve.

2.8.1.1 Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.1/CSA 4.1 when input is 75,000 BTU per hour or less or ANSI Z21.10.3/CSA 4.3 for heaters with input greater than 75,000 BTU per hour.

2.9 PUMPS

2.9.1 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 totally enclosed, fan-cooled and shall have sufficient horsepower for the service required. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover.

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 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 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. 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.

2.11 MISCELLANEOUS PIPING ITEMS

2.11.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated or copper

alloy plates or polished stainless steel finish in finished spaces.
Provide paint finish on plates in unfinished spaces.

2.11.2 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.

2.11.2.1 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.

2.11.2.2 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

2.11.3 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.

2.11.4 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.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to [NFPA 90A](#) requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with [NFPA 90A](#). Installation of plastic pipe where in compliance with NFPA may be installed in accordance with [PPFA Fire Man](#). 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 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 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 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 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.

3.1.2.1 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.

3.1.2.2 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.

3.1.2.3 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.

3.1.2.4 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.

3.1.2.5 Other Joint Methods

3.1.3 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.

3.1.4 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.4.1 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 masonry wall as specified above. 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.

3.1.4.2 Flashing Requirements

Pipes passing through roof shall be installed through 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 be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to

provide a watertight seal. 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. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.4.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 1-1/2 inches; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 8 inches from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

3.1.4.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

- a. A standard roof coupling for threaded pipe up to 6 inches in diameter.
- b. A tack-welded or banded-metal rain shield around the pipe.

3.1.4.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs FLASHING REQUIREMENTS and WATERPROOFING, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.1.4.6 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

3.1.5 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.

3.1.6 Supports

3.1.6.1 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.

3.1.6.2 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 than 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.

3.1.6.3 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.

3.1.7 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 or where less than 18 inches of crawl space is provided under the floor. 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 .

3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. 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 Installation of Gas Water Heater

Installation shall conform to NFPA 54 for gas fired. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 24 inches just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

3.2.3 Heat Traps

Piping to and from each water heater and hot water storage tank shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

3.2.4 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

3.2.5 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.

3.2.6 Direct Fired and Domestic Water Heaters

Notify the Contracting Officer when any direct fired domestic water heater over 400,000 BTU/hour is operational and ready to be inspected and certified.

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, except at water closets intended for use by the physically handicapped where flushometer valves shall be mounted at approximately 30 inches above the floor and arranged to avoid interference with grab bars. In addition, for water closets intended for handicap use, the flush valve handle shall be installed on the wide side of the enclosure.

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. Installation of fixtures for use by the physically handicapped shall be in accordance with ICC A117.1 COMM.

3.3.4 Shower Bath 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, urinals, 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.

3.3.6 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. Access panels shall be as specified in.

3.3.8 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate **2 inches** above the flood rim of the funnel to provide an acceptable air gap.

3.3.9 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.

3.3.10 Shower Pans

Before installing shower pan, subfloor shall be free of projections such as nail heads or rough edges of aggregate. Drain shall be a bolt-down, clamping-ring type with weepholes, installed so the lip of the subdrain is flush with subfloor.

3.3.10.1 General

The floor of each individual shower, the shower-area portion of combination shower and drying room, and the entire shower and drying room where the two are not separated by curb or partition, shall be made watertight with a shower pan fabricated in place. The shower pan material shall be cut to size and shape of the area indicated, in one piece to the maximum extent practicable, allowing a minimum of **6 inches** for turnup on walls or partitions, and shall be folded over the curb with an approximate return of 1/4 of curb height. The upstands shall be placed behind any wall or partition finish. Subflooring shall be smooth and clean, with nailheads driven flush with surface, and shall be sloped to drain. Shower pans shall be clamped to drains with the drain clamping ring.

3.4 IDENTIFICATION SYSTEMS

3.4.1 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.

3.4.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.4.3 Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room.

3.5 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.

3.6 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.

3.6.1 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.

3.6.1.1 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.

3.6.1.2 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.

3.7 TESTS, FLUSHING AND DISINFECTION

3.7.1 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.

3.7.2 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.

3.7.3 System Flushing

3.7.3.1 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.

3.7.3.2 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.

3.7.4 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 each 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.

3.7.5 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 **AWWA 10084**. 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.

3.8 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.

3.9 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, minimum overall efficiency.

ET = Minimum thermal efficiency with 70 degrees F delta T.

SL = Standby loss is maximum (Btu/h) based on a 70 degrees F temperature difference between stored water and ambient requirements.

V = Rated volume in gallons

Q = Nameplate input rate in kW (Btu/h)

3.9.1 Storage Water Heaters

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
20	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
<p>SERVICE:</p> <p>A - Underground Building Soil, Waste and Storm Drain</p> <p>B - Aboveground Soil, Waste, Drain In Buildings</p> <p>C - Underground Vent</p> <p>D - Aboveground Vent</p> <p>E - Interior Rainwater Conductors Aboveground</p> <p>F - Corrosive Waste And Vent Above And Belowground</p> <p>G - Condensate Drain Aboveground</p> <p>* - Hard Temper</p>								

TABLE II						
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS						
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	
8	Seamless copper water tube, ASTM B88, ASTM B88M	X**	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
10	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Item 8	X	X	X	X
11	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Item 8	X	X	X	X
33	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B828	X	X		
	SERVICE: A - Cold Water Service Aboveground B - Hot and Cold Water Distribution 180 degrees F Maximum Aboveground C - Compressed Air Lubricated D - Cold Water Service Belowground Indicated types are minimum wall thicknesses. ** - Type L - Hard *** - Type K - Hard temper with brazed joints only or type K-soft temper without joints in or under floors **** - In or under slab floors only brazed joints				

TABLE III				
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT				
<u>FUEL</u>	<u>STORAGE CAPACITY GALLONS</u>	<u>INPUT RATING</u>	<u>TEST PROCEDURE</u>	<u>REQUIRED PERFORMANCE</u>
A. STORAGE WATER HEATERS				
Gas	1,000 (Btu/h)/gal max.	75,000 Btu/h	ANSI Z21.10.3/CS	ET = 80 percent min. SL = 1.3+38/V max.
TERMS: EF = Energy factor, minimum overall efficiency. ET = Minimum thermal efficiency with 70 degrees F delta T. SL = Standby loss is maximum Btu/h based on a 70 degree F temperature difference between stored water and ambient requirements. V = Rated storage volume in gallons Q = Nameplate input rate in Btu/h				

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 03 00.00 20

BASIC MECHANICAL MATERIALS AND METHODS

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 B117 (2019) Standard Practice for Operating
Salt Spray (Fog) Apparatus

1.2 RELATED REQUIREMENTS

This section applies to all sections of Divisions: 21, FIRE SUPPRESSION; 22, PLUMBING; and 23, HEATING, VENTILATING, AND AIR CONDITIONING of this project specification, unless specified otherwise in the individual section.

1.3 QUALITY ASSURANCE

1.3.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use 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.

1.3.2 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.

1.3.3 Service Support

The equipment items must 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 must 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.

1.3.4 Manufacturer's Nameplate

For each item of equipment, provide 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.

1.3.5 Modification of References

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.

1.3.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.3.5.2 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, must 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 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors must conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and must have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.6 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 must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

Instruction must 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 must 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.

1.7 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

Not Used

PART 3 EXECUTION

3.1 PAINTING OF NEW EQUIPMENT

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

3.1.1 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 must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with [ASTM B117](#), and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must 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 must 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 must be designed for the temperature service.

3.1.2 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 must 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 must 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 must 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 1 mil; and two coats of enamel applied to a minimum dry film thickness of 1 mil per coat.
- b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F must 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 must receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

-- End of Section --

SECTION 23 05 48.19

SEISMIC BRACING FOR HVAC
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 (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 7-16 (2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C105/A21.5 (2018) Polyethylene Encasement for Ductile-Iron Pipe Systems

AWWA C116/A21.16 (2015) Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray Iron Fittings

AWWA C153/A21.53 (2019) Ductile-Iron Compact Fittings for Water Service

AWWA C213 (2015) Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M (2019) Standard Specification for Carbon Structural Steel

ASTM A53/A53M (2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A500/A500M	(2021a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
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 A603	(2019) Standard Specification for Zinc-Coated Steel Structural Wire Rope
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F891	(2016) Standard Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

FEMA P-414	(January 2004) Installing Seismic Restraints for Duct and Pipe
------------	--

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC ES AC156	(2012) Acceptable Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components
ICC ES AC193	(2012) Acceptance Criteria for Mechanical Anchors in Concrete Elements

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC (2021) International Building Code

METAL FRAMING MANUFACTURERS ASSOCIATION (MFMA)

MFMA-4 (2004) Metal Framing Standards Publication

NSF INTERNATIONAL (NSF)

NSF/ANSI 61 (2022) Drinking Water System Components - Health Effects

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1981 (2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01 (2019, with Change 1, 2022) Structural Engineering

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 to the mechanical equipment and mechanical systems both inside and outside of the building along with exterior utilities and systems listed below. 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 Mechanical Equipment

Mechanical equipment to be seismically protected must include the following items to the extent required on the drawings or in other sections of these specifications:

Equipment/Components with $I_p = 1.0$

Expansion Air Separator Tanks	Valves and Fittings for Piping
-------------------------------	--------------------------------

Heat Exchangers	Steam-fed Kitchen Appliances
Water Chiller Units	
	Air Handling Units
Pumps with Motors	
	Split System DX Units
Flash Tanks	Unit Heaters
	Exhaust, Return and Misc. Fans
	Pumps
	Unitary HVAC Systems
	Fan Coil Units
	Instrumentation and Control for HVAC

Equipment/Components with $I_p = 1.5$ (Designated Seismic Systems)
Insert edited list here similar to one above for $I_p = 1.0$

1.2.3 Mechanical Systems

Mechanical systems to be seismically protected must include the following items to the extent required on the drawings or in this or other sections of these specifications:

Mechanical systems with $I_p = 1.0$

- a. All Piping and Ducts Inside the Building Except as Specifically Stated Below Under "Items Not Covered By This Section".
- b. Chilled Water Distribution Systems Outside of Buildings.
- c. Steam, Water, and Gas Piping Outside of Buildings.
- d. All Water Supply Systems Outside of Buildings.

- g. Heat Distribution Systems (Supply, Return, steam and Condensate Return) Outside of Buildings.
- h. Refrigerant Piping Outside the Building.

m. Ductwork Outside of Buildings.

o.

Mechanical systems with $I_p = 1.5$ (Designated Seismic Systems)
Insert edited list here similar to one above for $I_p = 1.0$

1.2.4 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 3-301-01, , 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 3-301-01 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 3-301-01 are based on strength design; therefore, AISC 325 Specifications must be used for the design. The bracing for the mechanical equipment designated in paragraph 1.2.2 and systems designated in paragraph 1.2.3 must be developed by the Contractor.

1.2.5 Items Not Covered By This Section

1.2.5.1 Items Requiring No Seismic Restraints

Seismic restraints are not required for the following items:

- a. Gas piping less than 1 inch nominal pipe size.
- b. Piping in boiler and mechanical equipment rooms less than 1-1/4 inches nominal pipe size.
- c. All other piping equal to or less than 3 inches nominal pipe size.
- d. Rectangular air handling ducts less than 6 square feet in cross sectional area.
- e. Round air handling ducts less than 28 inches in diameter.

- f. Piping suspended by individual hangers 12 inches or less in length from the top of pipe to the bottom of the supporting structural member where the hanger is attached, except as noted below.
- g. Ducts suspended by hangers 12 inches or less in length from the top of the duct to the bottom of the supporting structural member, except as noted below.

In exemptions f. and g. all hangers must meet the length requirements. If the length requirement is exceeded by one hanger in the run, brace the entire run. Seismically protect interior piping and ducts not listed above in accordance with the provisions of this specification.

Non-critical items may require seismic restraints if adjacent to critical equipment or systems that must remain operational after an earthquake and could be compromised by impact with non-critical adjacent components.

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. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. 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

Coupling and Bracing

Flexible Couplings or Joints

Equipment Restraint

Contractor Designed Bracing; G

SD-03 Product Data

Coupling and Bracing; G

Flexible Couplings Or Joints; G

Equipment Restraint; G

Contractor Designed Bracing; G

Snubbers

Anchor Bolts

Vibration Isolators

SD-05 Design Data

Design Calculations

SD-06 Test Reports

Anchor Bolts; G

PART 2 PRODUCTS

2.1 GENERAL DESIGN REQUIREMENTS

Submit detailed seismic restraint drawings for mechanical equipment, duct systems, piping systems and any other mechanical systems along with calculations, catalog cuts, templates, and erection and installation details, as appropriate, for the items listed below. Indicate thickness, type, grade, class of metal, and dimensions; and show construction details, reinforcement, anchorage, and installation with relation to the building construction. Calculations must be stamped, by a registered structural engineer, and verify the capability of structural members to which bracing is attached for carrying the load from the brace. Include drawing for Mission Critical Equipment indicating the equipment location in the facility sufficient to be used for the installation. 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.

2.2 EQUIPMENT RESTRAINT

Equipment must be rigidly or flexibly mounted as indicated in the specifications and/or drawings depending on vibration isolation requirements as follows below.

Roof mounted equipment such as cooling towers and condensers, both vibration isolated and nonisolated, must have support members designed and anchored to building structural steel or concrete as required for seismic restraint and wind loads.

2.2.1 Rigidly (Base and Suspended) Mounted Equipment

HVAC equipment furnished under this contract must be rigidly mounted using cast-in-place anchor bolts 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](#). For any rigid equipment which is rigidly anchored, provide flexible joints for piping, ductwork, 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. 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.

Roof mounted HVAC equipment roof curbs, framing and attachment to equipment and structure must be designed and braced to withstand seismic loads. Designated Seismic Systems (DSS) assigned to Seismic Design Category (SDC) C, D, E, or F and Risk Category IV components needed for continued operation after an earthquake must have two nuts provided on each anchor bolt.

2.2.2 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 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 manufacturer's will be a member of VISCMA. Design force, F_p , must be doubled for vibration isolators with an air gap greater than 0.25 inches as specified in ASCE 7-16, Chapter 13. Housed springs must not be used for seismic restraint applications because they cannot resist uplift.

2.3 BOLTS AND NUTS

Hex head bolts, and heavy hexagon nuts must be ASTM A325 or ASTM A490 bolts and ASTM A563 nuts. Provide bolts and nuts galvanized in accordance with ASTM A153/A153M when used underground or exposed to weather.

2.4 FLEXIBLE JOINTS

Flexible joints must have same pressure and temperature ratings as adjoining pipe. Braided hoses must not be used where there is torsional or axial movement unless manufacturer allows it.

2.4.1 Braided Hose Expansion Joint

Braided hose expansion joint(s) must be installed in the locations indicated on the drawings and as required to accommodate any thermal expansion, contraction or seismic movement of the piping system. Joints must consist of two parallel sections of corrugated metal hose, compatible braid, and 180 degree return bend with inlet and outlet connections. Field fabricated loops are not acceptable. Braided hose expansion joint(s) must be installed in the locations indicated on the drawings and as required to accommodate any thermal expansion, contraction or seismic movement of the piping system. Joints must consist of two parallel sections of corrugated metal hose, compatible braid, and 180 degree return bend with inlet and outlet connections. Field fabricated loops must not be acceptable. Braided hose in a 60 degree flexible V loop arrangement must be used for small diameter pipe connections to coils in variable-air-volume (VAV) terminal units and fan coil units installed in suspended ductwork whether braced or unbraced.

All braided hose expansion joints must be manufactured in accordance with the documented manufacturers weld procedure specifications. The procedure qualification record must be used to document the execution of this procedure and must follow the general "guidelines" of ASME Section IX. Each individual welder must conform to the in-house procedure qualification record and be qualified prior to each production lot. The

testing of each individual welder must be documented in a welding procedure qualification record.

2.4.1.1 Corrugated Hose

Corrugated hose must be Type 304 stainless steel . Braid must be Type 304 stainless steel for any series 300 stainless steel hose . Fittings materials of construction and end fitting type must be consistent with pipe material and equipment/ pipe connection fittings. Copper fittings must not be attached to stainless steel hose.

2.4.1.2 Flexible Hose Expansion Loops

Flexible hose expansion loops must have a factory supplied, hanger / support lug located at the bottom of the 180deg return. Flexible hose expansion loop(s) must be rated with an operating pressure which is the same as the adjoining pipe. The operating pressure must be based on burst pressure with a 4 to 1 safety factor. For steam service, the operating pressure must be based on burst pressure with a 8 to 1 safety factor.

2.4.2 Double Ball Flexible Expansion Joint

Install flexible expansion joints manufactured of ductile iron conforming to the material requirements of [ASTM A536](#) and [AWWA C153/A21.53](#) in the locations indicated on the drawings. Provide foundry certification of material upon request. Each flexible expansion joint must be pressure tested prior to shipment against its own restraint to a minimum of 350 psi (250 psi for flexible expansion joints 2 inch and 30 inches diameter and larger.) A minimum 2:1 safety factor, determined from the published pressure rating, must apply. Factory Mutual Approval for the 3 inch through 12 inch sizes is required. Each flexible expansion joint must consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20°, 2" - 12"; 15°, 14" - 36"; 12°, 42"-48" and 4-inches minimum expansion. Additional expansion sleeves must be available and easily added or removed at the factory or in the field. Both standardized mechanical joint and flange end connections must be available.

2.4.2.1 Internal Surfaces

Line all internal surfaces (wetted parts) with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of [AWWA C213](#). Sealing gaskets must be constructed of EPDM. The coating must meet [NSF/ANSI 61](#).

2.4.2.2 Exterior Surfaces

Coat exterior surfaces with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of [AWWA C116/A21.16](#). Include appropriately sized polyethylene sleeves, meeting [AWWA C105/A21.5](#), for direct buried applications.

2.4.3 Double Ball Flexible Expansion Joint Gravity Drain (Non-Pressurized)

Flexible expansion joints gravity drain must be installed in the locations indicated on the drawings and must be manufactured of pvc. All connections whether solvent weld or mechanical must be restrained to allow movement to be transferred to expansion joint. Each ball must allow up to 15 degrees deflection.

End connection outside diameters must be compatible with [ASTM D1785](#), [ASTM D2665](#) and [ASTM F891](#) PVC pipe and are to be solvent welded.

2.5 SWAY BRACING MATERIALS

Material used for members listed in this section and on the drawings, must be structural steel conforming with the following:

- a. Plates, rods, and rolled shapes, [ASTM A36/A36M](#).
- b. Wire rope, [ASTM A603](#) pre-stretched. Class B galv coating Ferrule clamps must be qualified by testing for use in seismic applications per [VISCMA 412](#). A minimum of two clamps are required on each end of wire rope.
- c. Tubes, [ASTM A500/A500M](#), Grade B.
- d. Pipes, [ASTM A53/A53M](#), Grade B.
- e. Angles, [ASTM A36/A36M](#).
- f. Channels (Struts) with in-turned lips and associated hardware for fastening to channels at random points conforming to [MFMA-4](#)

2.6 MULTIDIRECTIONAL SEISMIC [SNUBBERS](#)

Install multidirectional seismic snubbers employing elastomeric pads on floor- or slab-mounted equipment and large piping as detailed on drawings. These snubbers must provide [1/4 inch](#) free vertical and horizontal movement from the static deflection point. Snubber medium must consist 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.

PART 3 EXECUTION

3.1 [COUPLING AND BRACING](#)

- a. Submit detail drawings, as specified here and throughout this specification, along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals must be complete in detail; must indicate thickness, type, grade, class of metal, and dimensions; and must show construction details, reinforcement, anchorage, and installation with relation to the building construction.
- b. Provide coupling installation conforming to the details shown on the drawings. Provisions of this paragraph apply to all piping within a [5 foot](#) line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers must be braced at the most frequent interval as determined by applying the requirements of this specification to each piping run on the common support.
- c. Size bracing components as required for the total load carried by the common supports. Bracing rigidly attached to pipe flanges, or similar, must not be used where it would interfere with thermal expansion of piping.

- d. Adjust isolators and restraints after piping systems has been filled and equipment is at its operating weight, following the manufacturer's written instructions.
- e. 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

Provide joints capable of accommodating seismic displacements for vertical piping between floors of the building, where pipes pass through a building seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators. Provide horizontal piping across expansion joints to accommodate the resultant of the drifts of each building unit in each orthogonal direction. For threaded piping, provide swing joints made of the same piping material. For piping with manufactured ball joints the seismic drift must be 0.015 [feet per foot](#) of height above the base where the seismic separation occurs; this drift value must be used in place of the expansion given in the manufacturer's selection table.

3.3 FLEXIBLE COUPLINGS OR JOINTS

3.3.1 Building Piping

Provide flexible couplings or joints in building piping at bottom of all pipe risers for pipe larger than [3-1/2 inches](#) in diameter. Laterally brace flexible couplings or joints without interfering with the action of the flexible coupling or joint. Cast iron waste and vent piping need only comply with these provisions when caulked joints are used. Flexible bell and spigot pipe joints using rubber gaskets may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to satisfy these requirements.

3.4 PIPE SLEEVES

Size pipe sleeves in interior non-fire rated walls as indicated on the drawings to provide clearances that will permit differential movement of piping without the piping striking the pipe sleeve.

3.5 SPREADERS

Provide spreaders between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than [4 inches](#) apart. Apply spreaders at same interval as sway braces at an equal distance between the sway braces. If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack. Apply spreaders to surface of bare pipe and over insulation on insulated pipes utilizing high-density inserts and pipe protection shields in accordance with the requirements of Section [23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS](#).

3.6 SWAY BRACES FOR PIPING

Provide sway braces to prevent movement of the pipes under seismic loading. Provide braces in both the longitudinal and transverse directions, relative to the axis of the pipe. Provide sufficient braces for equipment to resist a horizontal force as specified in [UFC 3-301-01](#)

without exceeding safe working stress of bracing components. Provide bracing that does not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications. For seismic analysis of horizontal pipes, the equivalent static force should be considered to act concurrently with the full dead load of the pipe, including contents.

3.6.1 Transverse Sway Bracing

Provide transverse sway bracing for steel and copper pipe at intervals not to exceed those shown on the drawings. All runs (length of pipe between end joints) must have a minimum of transverse bracing at each end. Provide transverse sway bracing for pipes of materials other than steel and copper at intervals not to exceed the hanger spacing as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.6.2 Longitudinal Sway Bracing

Provide longitudinal sway bracing at 40 foot intervals unless otherwise indicated. All runs (length of pipe between end joints) must have one longitudinal brace minimum. Construct sway braces in accordance with the drawings. Do not use branch lines, walls, or floors as sway braces.

3.6.3 Vertical Runs

Run is defined as length of pipe between end joints. Do not brace vertical runs of piping no more than 10 foot vertical intervals. Braces for vertical runs must be above the center of gravity of the segment being braced. Flexible couplings should be provided at the bottoms of risers for pipes larger than 3.5 in. (89 mm) in diameter. Flexible couplings and expansion joints should be braced laterally and longitudinally unless such bracing would interfere with the action of the couplings or joints. When pipes enter buildings, flexible couplings should be provided to allow for relative movement between the soil and building. Construct all sway braces in accordance with the drawings. Attach sway braces to the structural system. Do not connect to branch lines, walls, or floors.

3.6.4 Clamps and Hangers

Apply clamps or hangers on uninsulated pipes directly to pipe. Insulated piping must have clamps or hangers applied over insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

Hanger rod stiffener angle or strut bracing must be securely attached by a series of attachment clamps manufactured from a one piece metal stamping and must include all require attachment hardware and locking nuts. Attachment clamps made from aluminum or cast iron must not be used in seismic applications. Do not weld vertical braces to hanger rods.

3.7 SWAY BRACES FOR DUCTS

3.7.1 Braced Ducts

Provide bracing details and spacing for rectangular and round ducts in accordance with SMACNA 1981. However, the design seismic loadings for these items must not be less than loadings obtained using the procedures in UFC 3-301-01. Bracing must not attach to duct joints. Use shortest screws possible when penetrating ductwork to minimize airflow noise inside duct.

3.7.2 Unbraced Ducts

Attach hangers for unbraced ducts to the duct within 2 inches of the top of the duct with a minimum of two #10 sheet metal screws in accordance with FEMA P-414. Use shortest screws possible when penetrating ductwork to minimize airflow noise inside duct. Install unbraced ducts with a 6 inch minimum clearance to vertical ceiling hanger wires.

3.8 EQUIPMENT

3.8.1 General

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.

3.8.2 Controls

Ensure that controls for critical equipment that must remain operational after an earthquake are certified per paragraph 3.11 SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT and are served by emergency power as required.

3.9 ANCHOR BOLTS

3.9.1 Cast-in-Place Anchor Bolts

Use templates to locate cast-in-place bolts accurately and securely in formwork. Anchor bolts must have 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.

3.9.2 Drilled-In Anchor Bolts

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.

3.9.2.1 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% of the specified torque, 100% 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.

3.9.2.2 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.

3.9.2.3 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.

3.10 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.

3.10.1 Torque Wrench Testing

Perform torque wrench testing on not less than 50 percent of the total installed applied torque 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 $\frac{3}{8}$ 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.

3.10.2 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 in accordance with [ASTM E488/E488M](#) or [ICC ES AC193](#). At least 10 percent of each type and size of 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 type and size anchors not previously tested must be tested until 10 percent of those type consecutive anchors pass. Remove and replace failed anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout.

3.11 SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT

Equipment and components (including controls) 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](#) 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.

Mechanical 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.

3.12 SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS AND EQUIPMENT

Perform special inspections for seismic-resisting mechanical systems, equipment and components designated mechanical seismic systems and equipment per [ICC IBC 1705.12.4](#); and plumbing and mechanical components per [ICC IBC 1705.12.6](#). Periodic special inspections will be conducted on mechanical equipment as required by Section 1705.12 of the International Building Code and paragraph 2-5.4 of [UFC 3-301-01](#). Provide a Statement of Special Inspections and Final Report in accordance with paragraph 2-2.4.3 of [UFC 3-301-01](#).

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

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 (2016) Ventilation for Acceptable Indoor
Air Quality

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1 (2002; 6th ed) National Standards for
Total System Balance

AABC MN-4 (1996) Test and Balance Procedures

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 Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING." 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.

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 system, including records of existing conditions, and 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

Requirements for price breakdown of HVAC TAB work are specified in Section 01 20 00 PRICE AND PAYMENT PROCEDURES.

Requirements for construction scheduling related to HVAC TAB work are specified in Section 01 32 17.00 20 COST LOADED NETWORK ANALYSIS SCHEDULES (NAS).

Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Records of Existing Conditions; G

Independent TAB Agency and Personnel Qualifications; G

TAB Design Review Report; G

SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms; G

SD-03 Product Data

Equipment and Performance Data; G

TAB Related HVAC Submittals; G

A list of the TAB Related HVAC Submittals, no later than days after the approval of the TAB team engineer and assistant.

SD-06 Test Reports

Completed Pre-Final DALT Report; G

Certified Final DALT Report; G

Prerequisite HVAC Work Checkout List For Proportional Balancing; G

Certified Final TAB Report for Proportional Balancing; G

Prerequisite HVAC Work Checkout List For Season 1; G

Certified Final TAB Report for Season 1; G

Prerequisite HVAC Work Checkout List For Season 2; G

Certified Final TAB Report for Season 2; G

SD-07 Certificates

Independent TAB Agency and Personnel Qualifications; G

DALT and TAB Submittal and Work Schedule; G

TAB Pre-Field Engineering Report; G

Instrument Calibration Certificates; G

DALT and TAB Procedures Summary; G

Completed Pre-Final DALT Work Checklist; G

Advance Notice of Pre-Final DALT Field Work; G

Advance Notice of TAB Field Work for Proportional Balancing; G

Advance Notice of TAB Field Work for Season 1; G

Advance Notice of TAB Field Work for Season 2 G

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.

1.5.1.1 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.

1.5.1.2 Qualifications

a. 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.

b. 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.

c. 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. The TAB Specialist must participate in the commissioning process.

1.5.1.3 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.

1.5.2 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.

1.5.2.1 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.

1.5.2.2 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.

1.5.2.3 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.
 - 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 Season 1 and Season 2 TAB field check.
- 1.5.2.4 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.

1.5.3 Sequencing and Scheduling

1.5.3.1 DALT and TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section.

a. 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.

b. 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.

1.5.3.2 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.

1.5.4 Subcontractor Special Requirements

Perform all work in this section in accordance with the paragraph SUBCONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS, stating that all contract requirements of this section must be accomplished directly by a first tier subcontractor. No work may be performed by a second tier subcontractor.

1.5.5 Instrument Calibration Certificates

It is the responsibility of the TAB firm to provide instrumentation that meets the minimum requirements of the standard under which the TAB Firm's qualifications are approved for use on a project. Instrumentation must be in proper operating condition and must be applied in accordance with the instrumentation's manufacturer recommendations.

All instrumentation must bear a valid NIST traceable calibration certificate during field work and during government acceptance testing. All instrumentation must be calibrated within no later than one year of the date of TAB work or government acceptance testing field work.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section as specified in Appendix A WORK DESCRIPTIONS OF PARTICIPANTS.

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 meeting the additional requirements specified in Appendix B REPORTS - DALT and TAB. Data required by those data report forms shall be furnished by the TAB team. Prepare the report neatly and legibly; the Pre-final DALT report shall provide the basis for the Final DALT Report.

TAB supervisor shall review, approve and sign 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 shall assemble, review, approve, sign and submit the Final DALT Report in compliance with Appendix B REPORTS - DALT and TAB 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, chilled water, DX and steam 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:

- a. For air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."

Do not determine entering and leaving wet and dry bulb temperatures by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

- b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

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.

3.4.3.2 Air Handling Units

Air handling unit systems including fans (air handling unit fans, exhaust fans and winter ventilation fans), coils, ducts, plenums, mixing boxes, terminal units, variable air volume boxes, and air distribution devices for supply air, return air, outside air, mixed air relief air, and makeup air.

3.4.3.3 Makeup Air Units (DOAS)

Makeup air unit systems including fans, coils, ducts, plenums, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.

3.4.3.4 Fan Coils

Fan coil unit systems including fans, coils, ducts, plenums, and air distribution devices for supply air, return air, and outside air.

3.4.3.5 Exhaust Fans

Exhaust fan systems including fans, ducts, plenums, grilles, and hoods for exhaust air.

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 With Seasonal Limitations

3.4.5.1 Performance Tests

Accomplish proportional balancing TAB work on the air distribution systems and water distribution systems, in other words, accomplish adjusting and balancing of the air flows and water flows, any time during the duration of this contract, subject to the limitations specified elsewhere in this section. However, accomplish, within the following seasonal limitations, TAB work on HVAC systems which directly transfer thermal energy.

3.4.5.2 Season Of Maximum Load

Visit the contract site for at least two TAB work sessions for Season 1 and Season 2 field measures. Visit the contract site during the season of maximum heating load and visit the contract site during the season of maximum cooling load, the goal being to TAB the operational performance of the heating systems and cooling systems under their respective maximum outdoor environment-caused loading. During the seasonal limitations, TAB the operational performance of the heating systems and cooling systems.

3.4.5.3 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 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.

3.4.7 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.

3.4.8 TAB Reports

Additional requirements for TAB Reports are specified in Appendix B
REPORTS - DALT and TAB

3.4.9 Quality Assurance - COTR TAB Field Acceptance Testing

3.4.9.1 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, computer room units, and air handling units (rooftop and central stations).

Group 2: 25 percent of the VAV terminal boxes and associated diffusers and registers.

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.

3.4.9.2 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.

3.4.9.3 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.

3.7 APPENDICES

Appendix A WORK DESCRIPTIONS OF PARTICIPANTS
Appendix B REPORTS - DALT and TAB
Appendix C DALT AND TAB SUBMITTAL AND WORK SCHEDULE
Appendix D REQUIREMENTS FOR DUCT AIR LEAK TESTING

Appendix A

WORK DESCRIPTIONS OF PARTICIPANTS

The Contractor is responsible for ensuring compliance with all requirements of this specification section. However, the following delineation of specific work items is provided to facilitate and co-ordinate execution of the various work efforts by personnel from separate organizations.

1. Contractor

- a. HVAC documentation: Provide pertinent contract documentation to the TAB Firm, to include the following: the contract drawings and specifications; copies of the approved submittal data for all HVAC equipment, air distribution devices, and air/water measuring/balancing devices; the construction work schedule; and other applicable documents requested by the TAB Firm. Provide the TAB Firm copies of contract revisions and modifications as they occur.
- b. Schedules: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.
- c. Pre-DALT and TAB meeting: Arrange and conduct the Pre-DALT and TAB meeting. Ensure that a representative is present for the sheet metal contractor, the mechanical contractor, the electrical contractor, and the automatic temperature controls contractor.
- d. Coordinate Support: Provide and coordinate support personnel required by the TAB Firm in order to accomplish the DALT and TAB field work. Support personnel may include factory representatives, HVAC controls installers, HVAC equipment mechanics, sheet metal workers, pipe fitters, and insulators. Ensure support personnel are present at the work site at the times required.
- e. Correct Deficiencies: Ensure the notifications of Construction Deficiencies are provided as specified herein. Refer to the paragraph CONSTRUCTION DEFICIENCIES. Correct each deficiency as soon as practical with the Contracting Officer, and submit revised schedules and other required documentation.
- f. Pre-TAB Work Checklists: 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 pre-TAB work checklist items, the deficiencies pointed out by the TAB team supervisor in the design review report.

Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's DALT and TAB Work Procedures Summary. Do not allow the TAB team to commence TAB field work until all of the following are completed.

- g. Give Notice of Testing: Submit advance notice of [proportional balancing](#), [Season 1](#), and [Season 2](#) TAB field work accompanied by completed prerequisite HVAC Work List

- h. Insulation work: Ensure that no insulation is shall not be installed on ducts to be DALT'd until DALT work on the subject ducts is complete.

Ensure the duct and piping systems are properly insulated and vapor sealed upon the successful completion and acceptance of the DALT and TAB work.

2. 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. Schedule: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.
- c. Submittals: Provide the submittals specified herein.
- d. Pre-DALT/TAB meeting: Attend meeting with Contractor. Ensure TAB personnel that will be involved in the TAB work under this contract attend the meeting.
- e. 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.
- f. 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 DALT and TAB Procedures Summary, the during the DALT or TAB field work.

Ensure the Contractor is properly notified and aware of all support personnel needed to perform the TAB work. Maintain communication with the Contractor regarding support personnel throughout the duration of the TAB field work, including the TAB field acceptance testing checking.

Ensure all inspections and verifications for the Pre-Final DALT and Pre-TAB Checklists are completely and successfully conducted before DALT and TAB field work is performed.

- g. Advance Notice: Monitor the completion of the duct system installations and provide the Advance Notice for Pre-Final DALT field work as specified herein.
- h. Technical Assistance: Provide technical assistance to the DALT and TAB field work.
- i. Deficiencies Notification: Ensure the notifications of Construction Deficiencies are provided as specified herein. Comply with requirements of the paragraph CONSTRUCTION DEFICIENCIES. Resolve each deficiency as soon as practical and submit revised schedules and other

required documentation.

- j. Procedures: Develop the required TAB procedures for systems or system components not covered in the TAB Standard.

3. 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 work list, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

Appendix B

REPORTS - DALT and TAB

All submitted documentation must be typed, neat, and organized. All reports must have a waterproof front and back cover, a title page, a certification page, sequentially numbered pages throughout, and a table of contents. Tables, lists, and diagrams must be titled. Generate and submit for approval the following documentation:

1. DALT and TAB Work Execution Schedule

Submit a detailed schedule indicating the anticipated calendar date for each submittal and each portion of work required under this section. For each work entry, indicate the support personnel (such as controls provider, HVAC mechanic, etc.) that are needed to accomplish the work. Arrange schedule entries chronologically.

2. DALT and TAB Procedures Summary

Submit a detailed narrative describing all aspects of the DALT and TAB field work to be performed. Clearly distinguish between DALT information and TAB information. Include the following:

- a. A list of the intended procedural steps for the DALT and TAB field work from start to finish. Indicate how each type of data measurement will be obtained. Include what Contractor support personnel are required for each step, and the tasks they need to perform.
- b. A list of the project's submittals that are needed by the TAB Firm in order to meet this Contract's requirements.
- c. The schematic drawings to be used in the required reports, which may include building floor plans, mechanical room plans, duct system plans, and equipment elevations. Indicate intended TAB measurement locations, including where test ports need to be provided by the Contractor.
- d. The data presentation forms to be used in the report, with the preliminary information and initial design values filled in.
- e. A list of DALT and TAB instruments to be used, edited for this project, to include the instrument name and description, manufacturer, model number, scale range, published accuracy, most recent calibration date, and what the instrument will be used for on this project.
- f. A thorough checklist of the work items and inspections that need to be accomplished before DALT field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Pre-Final DALT Work Checklist before DALT field work can be accomplished.
- g. A thorough checklist of the work items and inspections that need to be accomplished before the Season 1 TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Season 1 Pre-TAB Work Checklist before the Season 1 TAB field work can be accomplished.
- h. A thorough checklist of the work items and inspections that need to be

accomplished before the Season 2 TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Season 2 Pre-TAB Work Checklist before the Season 2 TAB field work can be accomplished.

- i. The checklists specified above shall be individually developed and tailored specifically for the work under this contract. Refer to **NEBB PROCEDURAL STANDARDS**, Section III, "Preliminary TAB Procedures" under the paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" for examples of items to include in the checklists.

3. Design Review Report

Submit report containing the following information:

- a. Review the contract specifications and drawings to verify that the TAB work can be successfully accomplished 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.
- b. Submit a typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the DALT work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. If no deficiencies are evident, state so in the report.

4. Completed Pre-Final DALT Work Checklist

Report the data for the Pre-Final DALT Report meeting the following requirements:

- a. Submit a copy of the approved DALT and TAB Procedures Summary: Provide notations describing how actual field procedures differed from the procedures listed.
- b. Report format: Submit a comprehensive report for the DALT field work data using data presentation forms equivalent to the "Air Duct Leakage Test Summary Report Forms" located in the **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. Node numbers shall be included in the completed report forms to identify each duct section.
- c. Calculations: Include a copy of all calculations prepared in determining the duct surface area of each duct test section. Include in the DALT reports copy(s) of the calibration curve for each of the DALT test orifices used for testing.
- d. 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 are to be calibrated within one year of the date of use in the field; instrument calibration is to be traceable to the measuring standards of the National Institute of Standards and Technology.

- e. TAB Supervisor Approval: Include on the submitted report the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

5. Final DALT Report

On successful completion of all COTR field checks of the Pre-final DALT Report data for all systems, the TABS Supervisor shall assemble, review, sign and submit the Final DALT Report to the Contracting Officer for approval.

6. TAB Reports: Submit TAB Report for Proportional Balancing, Season 1, and Season 2 in the following manner:

- a. Procedure Summary: Submit a copy of the approved DALT and TAB Procedures Summary. When applicable, provide notations describing how actual field procedures differed from the procedures listed.
- b. Report format: Submit the completed data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed, approved and signed 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 shall be typewritten. Handwritten report forms or report data are not acceptable.
- c. 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:

Two Sleeping Rooms per floor and teh 2nd floor Laundry Room

- (1) Data shall be measured and compiled on a continuous basis for the period in which TAB work affecting those rooms is being done.
 - (2) Data shall be measured/recorded only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode. Provide a detailed explanation wherever a final measurement did not achieve the required value.
 - (3) Data may be compiled using direct digital controls trend logging where available. Otherwise, the Contractor shall temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls shall have been fully operational a minimum of 24 hours in advance of commencing data compilation. The specified data shall be included in the Season I and Season 2 TAB Report.
- d. Air System Diagrams: Provided updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations.
 - e. Air Static Pressure Profiles: Report static pressure profiles for air

duct systems including: DOAS-1 and DOAS-2. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. The static pressure report data shall include, in addition to AABC or NEBB or TABB required data, the following:

- (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, DX coils, hot water coils, steam coils, electric resistance heating 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, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

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.

- f. Duct Transverses: Report duct traverses for main and branch main supply, return, exhaust, relief and outside air ducts. The TAB Agency shall evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pitot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane".

- g. 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 shall 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.

- h. Performance Curves: The TAB Supervisor shall 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 shall include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturis and flow orifices TAB'd on the job.
- j. Data From TAB Field Work: After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and approval signature, using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms shall be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report shall be considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP.

Appendix C

DALT AND TAB SUBMITTAL AND WORK SCHEDULE

Perform the following items of work in the order listed adhering to the dates schedule specified below. Include the major items listed in this schedule in the project network analysis schedule required by Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS).

Submit TAB Agency and TAB Personnel Qualifications: Within 42 calendar days after date of contract award.

Submit the DALT and TAB Work Execution Schedule: within 14 days after receipt of the TAB agency and TAB personnel qualifications approval. Revise and re-submit this schedule 28 days prior to commencement of DALT work and 28 days prior to the commencement of TAB Season 1 work and TAB Season 2 work.

Submit the DALT and TAB Work Procedures Summary: within 14 days after receipt of the initial approved DALT and TAB Work Execution Schedule.

Meet with the COTR at the Pre-DALT/TAB Meeting: Within 28 calendar days after receipt of the approved initial DALT/TAB Execution Schedule.

Submit Design Review Report: Within 56 calendar days after the receipt of the approved initial DALT and TAB Work Execution Schedule.

Advance Notice of Pre-Final DALT Field Work: After the completed installation of the HVAC duct system to be DALT'd, submit to the Contracting Officer an Advance Notice of Pre-Final DALT Field Work accompanied by the completed Pre-Final DALT Work Checklist for the subject duct system.

Ductwork Selected for DALT: Within 14 calendar days after receiving an acceptable completed Pre-Final DALT Work Checklist, the Contracting Officer's technical representative (COTR) will select the project ductwork sections to be DALT'd.

DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected project ductwork.

Submit Pre-Final DALT Report: Within two working days 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.

Quality Assurance - COTR DALT Field Checks: Upon approval of the Pre-final DALT Report, the COTR's DALT field check work shall be scheduled with the Contracting Officer.

Submit Final DALT Report: Within 14 calendar days after completion of successful DALT Work Field Check, submit Season 1 TAB report.

Advance Notice of Season 1 TAB Field Work: At a minimum of 14 calendar days prior to Season 1 TAB Field Work, submit advance notice of TAB field work accompanied by completed Season 1 Pre-TAB Work Checklist.

Season 1 TAB Field Work: At a minimum of 84 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work.

Submit Season 1 TAB Report: Within 14 calendar days after completion of Season 1 TAB field work, submit initial Season 1 TAB report.

Season 1 Quality Assurance - COTR TAB Field Check: 30 calendar days after initial Season 1 TAB report is approved by the Contracting Officer, conduct Season 1 field check.

Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work and submit final.

Receive the approved TAB report: Within 21 calendar days, receive the report from Contracting Officer approved TAB report.

Advance Notice of Season 2 TAB Field Work: At a minimum of 126 calendar days after CCD, submit advance notice of Season 2 TAB field work accompanied by completed Season 2 Pre-TAB Work Checklist.

Season 2 TAB Field Work: Within 14 calendar days after date of advance notice of Season 2 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

Submit Season 2 TAB Report: Within 14 calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

Season 2 Quality Assurance - COTR TAB Field Checks: 28 calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

Complete Season 2 TAB Work: Within 14 calendar days after the completion of Season 2 TAB field data check, complete all TAB work.

Receive the approved TAB report: Within calendar 21 days, receive the report from Contracting Officer.

Appendix D			
REQUIREMENTS FOR DUCT AIR LEAK TESTING			
		SYSTEMS	
		Dedicated Outside Air System, DOAS-1,2	Fan Coil Unit, FCU-__
Duct System Static Pressure, in inches W.C.	for Supply	3	1
	for Return	-	-1
	for Exhaust	-1	-
	for Outside Air	-1	-
System Oval/Round Duct and Rectangular Duct SMACNA Seal Class	for Supply	A	A
	for Return	A	A
	for Exhaust	A	A
	for Outside Air	A	A
System Oval/Round Duct SMACNA Leak Class	for Supply	6	6
	for Return	-	6
	for Exhaust	6	-
	for Outside Air	6	-

Appendix D			
REQUIREMENTS FOR DUCT AIR LEAK TESTING			
		SYSTEMS	
		Dedicated Outside Air System, DOAS-1,2	Fan Coil Unit, FCU-__
System Rectangular Duct SMACNA Leak Class	for Supply	12	12
	for Return	-	24
	for Exhaust	24	-
	for Outside Air	24	-
Duct Test Pressure, in inches W.C.	for Supply	3	1
	for Return	-	1
	for Exhaust	1	-
	for Outside Air	1	-

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS
02/13, CHG 7: 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. 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 - IP (2019; Errata 1 2019; Errata 2-5 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 6-8 2021; Interpretation 1-4 2020; Interpretation 5-8 2021 Addenda AS-AQ 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE 90.1 - SI (2019; Errata 1-4 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 5-7 2021; Interpretation 1-4 2020; Interpretation 5-8 2021; Addenda AU-CM 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M (2018) Standard Specification for Stainless Steel Wire

ASTM B209 (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

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 C647	(2008; R 2013) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C755	(2019b) Standard Practice for Selection of Water Vapor Retarders 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 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 D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D2863	(2019) Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM D5590	(2000; R 2010; E 2012) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2022) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E2231	(2019) Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface

Burning Characteristics

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

NFPA 90B (2021) Standard for the Installation of Warm Air Heating and Air Conditioning 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

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI T403 OM (2015) Bursting Strength of Paper

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-3316 (1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation

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 94

(2013; Reprint Apr 2022) UL Standard for
Safety Tests for Flammability of Plastic
Materials for Parts in Devices and
Appliances

UL 723

(2018) UL Standard for Safety Test for
Surface Burning Characteristics of
Building Materials

UL 2818

(2013) GREENGUARD Certification Program
For Chemical Emissions For Building
Materials, Finishes And Furnishings

1.2 SYSTEM DESCRIPTION

1.2.1 General

Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

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 Contractor Quality Control approval. 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

Pipe Insulation Systems and Associated Accessories

Duct Insulation Systems and Associated Accessories

Equipment Insulation Systems and Associated Accessories

Recycled content for insulation materials; S

SD-03 Product Data

Pipe Insulation Systems; G

Duct Insulation Systems; G

Equipment Insulation Systems; G

SD-07 Certificates

Indoor air quality for adhesives; S

SD-08 Manufacturer's Instructions

Pipe Insulation Systems; G

Duct Insulation Systems; G

Equipment Insulation Systems; G

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.

2.1.1.1 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.

2.1.1.2 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 exceeds the requirements of [ASHRAE 90.1 - IP](#). 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 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the

cloth/material covering the insulation. To resist mold/mildew, lagging adhesive shall meet [ASTM D5590](#) with 0 growth rating. Lagging adhesives shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with [ASTM E84](#). Adhesive shall be [MIL-A-3316](#), Class 1, pigmented white and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations for pipe and duct insulation.

2.2.1.3 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 Corner Angles

Nominal [0.016 inch](#) aluminum [1 by 1 inch](#) with factory applied kraft backing. Aluminum shall be [ASTM B209](#), Alloy 3003, 3105, or 5005.

2.2.4 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.

2.2.5 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](#).

2.2.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth, with 20X20 maximum mesh size, and glass tape shall have maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with [ASTM E84](#). Tape shall be [4 inch](#) wide rolls. Class 3 tape shall be [4.5 ounces/square yard](#). Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial additive.

2.2.7 Staples

Outward clinching type monel .

2.2.8 Jackets

2.2.8.1 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, [0.016 inch](#) nominal thickness; [ASTM B209](#), Temper H14, Temper H16, Alloy 3003, 5005, or 3105. Corrugated aluminum jacket shall not be used outdoors. [Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter](#). Aluminum jacket circumferential seam bands shall be [2 by 0.016 inch](#) aluminum matching jacket material. Bands for insulation below ground shall be [3/4 by 0.020 inch](#) thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

2.2.8.2 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, ultraviolet (UV) resistant rating or treatment and moderate chemical resistance with minimum thickness [0.030 inch](#).

2.2.8.3 Vapor Barrier/Vapor Retarder

Apply the following criteria to determine which system is required.

- a. On ducts, piping and equipment operating below [80 degrees F](#) or located outside shall be equipped with a vapor barrier.

2.2.9 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. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. 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](#). Flexible elastomerics require (in addition to vapor barrier skin) vapor retarder jacketing for high relative humidity and below ambient temperature applications.

2.2.9.1 White Vapor Retarder All Service Jacket (ASJ)

ASJ is for use on hot/cold pipes, ducts, or equipment indoors or outdoors if covered by a suitable protective jacket. The product shall meet all physical property and performance requirements of [ASTM C1136](#), Type I, except the burst strength shall be a minimum of 85 psi. [ASTM D2863](#) Limited Oxygen Index (LOI) shall be a minimum of 31.

In addition, neither the outer exposed surface nor the inner-most surface contacting the insulation shall be paper or other moisture-sensitive material. The outer exposed surface shall be white and have an emittance of not less than 0.80. The outer exposed surface shall be paintable.

2.2.9.2 Vapor Retarder/Vapor Barrier Mastic Coatings

2.2.9.2.1 Vapor Barrier

The vapor barrier shall be self adhesive (minimum 2 mils adhesive, 3 mils embossed) greater than 3 plies standard grade, silver, white, black and embossed white jacket for use on hot/cold pipes. Permeability shall be less than 0.02 when tested in accordance with [ASTM E96/E96M](#). Products shall meet [UL 723](#) or [ASTM E84](#) flame and smoke requirements and shall be UV resistant.

2.2.9.2.2 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 in accordance with [ASTM C755](#), Section 7.2.2, Table 2, for insulation type and service conditions. The coating shall be nonflammable, fire resistant type. To resist mold/mildew, coating shall meet [ASTM D5590](#) with 0 growth rating. 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 determined pursuant to [ASTM C647](#).

2.2.9.3 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.

2.2.9.4 Polyvinylidene Chloride (PVDC) Film Vapor Retarder

The PVDC film vapor retarder shall have a maximum moisture vapor transmission of 0.02 perms, minimum puncture resistance of 150 Beach units, a minimum tensile strength in any direction of 30 lb/inch when tested in accordance with [ASTM D882](#), and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance

with ASTM E84.

2.2.9.5 Polyvinylidene Chloride Vapor Retarder Adhesive Tape

Requirements must meet the same as specified for Laminated Film Vapor Retarder above.

2.2.9.6 Vapor Barrier/Weather Barrier

The vapor barrier shall be greater than 3 ply self adhesive laminate -white vapor barrier jacket- superior performance (less than 0.0000 permeability when tested in accordance with ASTM E96/E96M). Vapor barrier shall meet UL 723 or ASTM E84 25 flame and 50 smoke requirements; and UV resistant. Minimum burst strength 185 psi in accordance with TAPPI T403 OM . Tensile strength 68 lb/inch width (PSTC-1000). Tape shall be as specified for laminated film vapor barrier above.

2.2.10 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.

2.2.11 Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2.12 Insulation Bands

Insulation bands shall be 1/2 inch wide; 26 gauge stainless steel.

2.2.13 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.

2.3.3 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 Calcium Silicate

ASTM C533, Type I indoor only, or outdoors above 250 degrees F pipe temperature. Supply insulation with the manufacturer's recommended factory-applied jacket/vapor barrier.

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 Factory 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 Rigid Insulation

Calculate the minimum thickness in accordance with ASHRAE 90.1 - IP .

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 or without integral vapor barrier as required by the service. In exposed locations, provide jacket with a white surface suitable for field painting.

2.4.2.2 Metal Jackets

2.4.2.2.1 Aluminum Jackets

ASTM B209, Temper H14, minimum thickness of 27 gauge (0.016 inch), with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside dimension 8 inches and larger. Provide corrugated surface jackets for jacket outside dimension 8 inches and larger. Provide stainless steel bands, minimum width of 1/2 inch.

2.4.2.3 Vapor Barrier/Weatherproofing Jacket

Vapor barrier/weatherproofing jacket shall be laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive), heavy duty white or natural).

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. 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

Apply insulation to unheated and uncooled piping and equipment. Do not compress flexible elastomeric cellular insulation at joists, studs, columns, ducts, and hangers. The insulation must not pull apart after a one hour period; replace any insulation found to pull apart after one hour.

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 and heat tracing 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 and/or NFPA 90B. 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

Flexible Elastomeric Cellular Insulation shall only be used on chilled and heating hot water piping that is 3/4" in size or less, and that is on piping within 6 feet of a fan coil unit connection. 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 with metal jacketing, 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 Floors

Extend the aluminum jacket from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

3.2.1.2.3 Penetrating Waterproofed Floors

Extend the aluminum jacket from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.

3.2.1.2.4 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.

3.2.1.2.5 Penetrating Roofs

Insulate pipe as required for interior service to a point flush with the top of the flashing and sealed with flashing sealant. Tightly butt the insulation for exterior application to the top of flashing and interior insulation. Extend the exterior aluminum jacket 2 inches down beyond the end of the insulation to form a counter flashing. Seal the flashing and counter flashing underneath with metal jacketing/flashing sealant.

3.2.1.2.6 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.

3.2.1.2.7 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.

3.2.1.3.2 Horizontal Pipes Larger Than 2 Inches and Below 60 Degrees F

Supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-58. An insulation insert of cellular glass, prefabricated insulation pipe hangers, or perlite above 80 degrees F shall be installed above each shield. The insert shall cover not less than the bottom 180-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.

3.2.1.3.3 Vertical Pipes

Supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-58 covering the 360-degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

3.2.1.3.4 Inserts

Covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, overlap the adjoining pipe jacket 1-1/2 inches, and seal as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall

conform to **ASTM C1136**, Type 1, and is allowed to be of a different material than the adjoining insulation material.

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 Pipes in high abuse areas.

In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, welded PVC , aluminum or flexible laminate cladding (comprised of elastomeric, plastic or metal foil laminate) laminated self-adhesive (minimum **2 mils** adhesive, **3 mils** embossed) vapor barrier/weatherproofing jacket, - less than 0.0000 permeability; (greater than 3 ply, standard grade, silver, white, black and embossed) aluminum jackets shall be utilized. Pipe insulation to the **6 foot** level shall be protected.

3.2.1.6 Pipe Insulation Material and Thickness

Pipe insulation materials must be as listed in Table 1 and must meet or exceed the requirements of **ASHRAE 90.1 - IP**.

TABLE 1					
Insulation Material for Piping					
Service					
	Material	Specification	Type	Class	VR/VB Req'd
Chilled Water (Supply & Return Piping, 40 F nominal)					
	Cellular Glass	ASTM C552	II	2	Yes
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		Yes
Heating Hot Water Supply & Return (Max 250 F)					
	Mineral Fiber	ASTM C547	I	1	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping					
	Cellular Glass	ASTM C552	II	2	No
Hot Domestic Water Supply & Recirculating Piping (Max 200 F)					

TABLE 1					
Insulation Material for Piping					
Service					
	Material	Specification	Type	Class	VR/VB Req'd
	Mineral Fiber	ASTM C547	I	1	No
Steam and Condensate Return (201 to 250 Degrees F)					
	Calcium Silicate	ASTM C533	I		No
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Condensate Drain Located Inside Building					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Steam and Condensate (251 to 350 Degrees F)					
	Calcium Silicate	ASTM C533	I		No
Note: VR/VB = Vapor Retarder/Vapor Barrier					

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	4-<8	> or = >8
Chilled Water (Supply & Return, 40 Degrees F nominal)						
	Cellular Glass	1.5	2	2	2.5	3
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Heating Hot Water Supply & Return (Max 250 F)						
	Mineral Fiber	1.5	1.5	2	2	2

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	4-<8	> or = >8
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
Hot Domestic Water Supply & Recirculating Piping (Max 200 F)						
	Mineral Fiber	1	1	1	1.5	1.5
Steam and Condensate Return (201 to 250 Degrees F)						
	Calcium Silicate	2.5	3	4	4	4.5
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel						
	Flexible Elastomeric Cellular	0.5	0.5	0.5	0.5	0.5
Condensate Drain Located Inside Building						
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Steam and Condensate (251 to 350 Degrees F)						
	Calcium Silicate	2.5	3.5	4.5	4.5	5

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. Make-up water.
- d. Chilled water.
- f. Air conditioner condensate drains.
- h. Exposed lavatory drains and domestic water lines serving plumbing

fixtures for handicap persons.

- i. Domestic cold and chilled drinking water.

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, silver, white, black and embossed for use with Mineral Fiber, Cellular Glass, and Phenolic Foam 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 janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets 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 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 - 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 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.
 - (2) If the Contractor elects to submit detailed drawings instead of edited MICA Plates, the detail drawings shall be technically equivalent to the edited MICA Plate submittal.
- 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.
- b. Steam.
- c. Condensate.
- d. Hot water heating.

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".

3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, a laminated self-adhesive (minimum **2 mils** adhesive, **3 mils** embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability (greater than 3 ply, standard grade, silver, white, black and embossed aluminum jacket, stainless steel or PVC jacket shall be applied.

PVC jacketing requires no factory-applied jacket beneath it, however an all service jacket shall be applied if factory applied jacketing is not furnished. Flexible elastomeric cellular insulation exposed to weather shall be treated in accordance with paragraph INSTALLATION OF FLEXIBLE ELASTOMERIC CELLULAR INSULATION in PART 3.

3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than **2 inches** at longitudinal and circumferential joints and shall be secured with bands at not more than **12 inch** centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping **60 degrees F** and below shall be sealed with metal jacketing/flashing sealant while overlapping to

prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an un-insulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.

3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed, and UV resistant).

3.3 DUCT INSULATION SYSTEMS INSTALLATION

Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

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	2.0
Fresh Air Intake Ducts	2.0
Warm Air Ducts	2.0
Relief Ducts	2.0
Fresh Air Intake Ducts	2.0

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.
- g. Coil headers and return bends.
- h. Coil casings.
- i. Fresh air intake ducts.
- j. Filter boxes.
- k. Mixing boxes (field-insulated).
- l. Supply fans (field-insulated).

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf, and rigid type where exposed, minimum density 3 pcf. Insulation for both concealed or exposed round/oval ducts shall be flexible type, minimum density 3/4 pcf or a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered. Insulation for all exposed ducts shall be provided with either a white, paint-able, factory-applied Type I jacket or a field applied vapor retarder/vapor barrier jacket coating finish as specified, the total field applied dry film thickness shall be approximately 1/16 inch. Insulation on all concealed duct 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 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 Concealed 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.

3.3.2.2 Installation on Exposed Duct Work

- a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than **12 inches** apart and not more than **3 inches** from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct **12 inches** and larger. One row shall be provided for each side of duct less than **12 inches**. Mechanical fasteners shall be as corrosion resistant as G60 coated galvanized steel, and shall indefinitely sustain a **50 lb** tensile dead load test perpendicular to the duct wall.
- b. Form duct insulation with minimum jacket seams. Fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder/barrier jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.

Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors.

- c. Impale insulation on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.
- d. Seal joints in the insulation jacket with a 4 inch wide strip of tape. Seal taped seams with a brush coat of vapor retarder coating.
- e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with tape and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.
- f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a flashing sealant.
- g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. 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.
- h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 3/4 pcf, attached as in accordance with MICA standards.

3.3.3 Insulation for Warm Air Duct

Insulation and vapor barrier shall be provided for the following warm air ducts and associated equipment:.

- a. Supply ducts.
- b. Return air ducts.
- c. Relief air ducts
- d. Flexible run-outs (field insulated).
- e. Plenums.
- g. Coil-headers and return bends.
- h. Coil casings.
- i. Fresh air intake ducts.
- j. Filter boxes.
- k. Mixing boxes.
- l. Supply fans.

Insulation for rectangular ducts shall be flexible type where concealed, and rigid type where exposed. Insulation on exposed ducts shall be provided with a white, paint-able, factory-applied Type II jacket, or

finished with adhesive finish. Flexible type insulation shall be used for round ducts, with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket. Adhesive finish where indicated to be used shall be accomplished by applying two coats of adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and flexible connections.

3.3.3.1 Installation on Concealed Duct

- a. For rectangular, oval and round ducts, 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 secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corner.
- 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 18 inch centers and not more than 18 inches from duct corners.
- d. The insulation shall be impaled on the mechanical fasteners where used. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.
- e. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.
- f. Insulation jacket shall overlap not less than 2 inches at joints and the lap shall be secured and stapled on 4 inch centers.

3.3.3.2 Installation on Exposed Duct

- a. For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 16 inches apart and not more than 6 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger and a minimum of one row for each side of duct less than 12 inches.
- b. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.
- c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin trimmed and bent over.

- d. Joints on jacketed insulation shall be sealed with a 4 inch wide strip of tape and brushed with vapor retarder coating.
- e. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with adhesive and stapled.
- f. Insulation terminations and pin punctures shall be sealed with tape and brushed with vapor retarder coating.
- g. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation, minimum density of 3/4 pcf attached by staples spaced not more than 16 inches and not more than 6 inches from the degrees of joints. Joints shall be sealed in accordance with item "d." above.

3.3.4 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 60 degrees F, ducts shall be insulated as specified for cold air duct.

3.3.5 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. Hand-holes.
- b. Boiler manholes.
- c. Cleanouts.
- d. ASME stamps.
- e. Manufacturer's nameplates.
- f. Duct Test/Balance Test Holes.

3.4.2 Insulation for Cold Equipment

Cold equipment below 60 degrees F: Insulation shall be furnished on equipment handling media below 60 degrees F including the following:

- a. Pumps.
- b. Refrigeration equipment parts that are not factory insulated.

- c. Drip pans under chilled equipment.
- d. Cold water storage tanks.
- e. Water softeners.
- f. Duct mounted coils.
- g. Cold and chilled water pumps.
- h. Pneumatic water tanks.
- i. Roof drain bodies.
- j. Air handling equipment parts that are not factory insulated.
- k. Expansion and air separation tanks.

3.4.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Material and thicknesses shall be as shown in Table 5:

TABLE 5		
Insulation Thickness for Cold Equipment (inches)		
Equipment handling media at indicated temperature		
	Material	Thickness (inches)
35 to 60 degrees F		
	Flexible Elastomeric Cellular	2

3.4.2.2 Pump Insulation

- a. Insulate pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible elastomeric cellular insulation. The box shall conform to the requirements of MICA Insulation Stds plate No. 49 when using flexible elastomeric cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.
- b. Exposed insulation corners shall be protected with corner angles.
- c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Flashing sealant shall be applied to parting line, between

equipment and removable section insulation, and at all penetrations.

3.4.2.3 Other Equipment

- a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.
- b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers except flexible elastomeric cellular which shall be adhered with contact adhesive. Insulation corners shall be protected under wires and bands with suitable corner angles.
- c. Cellular glass shall be installed in accordance with manufacturer's instructions. Joints and ends shall be sealed with joint sealant, and sealed with a vapor retarder coating.
- d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.
- e. Exposed insulation corners shall be protected with corner angles.
- f. Insulation on equipment with ribs shall be applied over 6 by 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 by 2 inches washers or shall be securely banded or wired in place on 12 inch centers.

3.4.2.4 Vapor Retarder/Vapor Barrier

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating or vapor barrier jacket shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Flashing sealant or vapor barrier tape shall be applied to parting line between equipment and removable section insulation.

3.4.3 Insulation for Hot Equipment

Insulation shall be furnished on equipment handling media above 60 degrees F including the following:

- a. Converters.
- b. Heat exchangers.
- c. Hot water generators.
- d. Water heaters.
- e. Pumps handling media above 130 degrees F.

- g. Hot water storage tanks.
- h. Air separation tanks.
- i. Surge tanks.
- j. Flash tanks.
- p. Condensate receivers.

3.4.3.1 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
	Calcium Silicate	4
200psig or 400 degrees F		
	Rigid Mineral Fiber	3
	Calcium Silicate	4
600 degrees F: Thickness necessary to limit the external temperature of the insulation to 120 F. Heat transfer calculations shall be submitted to substantiate insulation and thickness selection.		

3.4.3.2 Insulation of Pumps

Insulate pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing that does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line of the removable sections and penetrations.

3.4.3.3 Other Equipment

- a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.
- b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 12 inch centers except flexible elastomeric cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.
- c. On high vibration equipment, cellular glass insulation shall be set in a coating of bedding compound as recommended by the manufacturer, and joints shall be sealed with bedding compound. Mineral fiber joints shall be filled with finishing cement.
- d. Insulation on heads of heat exchangers shall be removable. The removable section joint shall be fabricated using a male-female shiplap type joint. Entire surface of the removable section shall be finished as specified.
- e. Exposed insulation corners shall be protected with corner angles.
- f. On equipment with ribs, such as boiler flue gas connection, draft fans, and fly ash or soot collectors, insulation shall be applied over 6 by 6 inch by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 by 2 inch washers or shall be securely banded or wired in place on 12 inch (maximum) centers.
- g. On equipment handling media above 600 degrees F, insulation shall be applied in two or more layers with joints staggered.
- h. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

3.4.4 Equipment Handling Dual Temperature Media

Below and above 60 degrees F: equipment handling dual temperature media shall be insulated as specified for cold equipment.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 09 23.13

BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC
09/22

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.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D (2018) Laboratory Methods of Testing
Dampers for Rating

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 135 (2012; Addenda AR 2013; Errata 1 2013; INT
1-9 2013; Errata 2 2013; INT 10-12 2014;
Errata 3-4 2014; Addenda AI-AY 2014; INT
13-17 2015; Errata 5 2015) BACnet-A Data
Communication Protocol for Building
Automation and Control Networks

ASHRAE 135.1 (Errata 1 2015; INT 1 2013; Addenda O
2014) Method of Test for Conformance to
BACnet

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.34 (2021) Valves - Flanged, Threaded and
Welding End

ASME B16.5 (2020) Pipe Flanges and Flanged Fittings
NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B31.1 (2020) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A126 (2004; R 2019) Standard Specification for
Gray Iron Castings for Valves, Flanges,
and Pipe Fittings

ASTM B117 (2019) Standard Practice for Operating
Salt Spray (Fog) Apparatus

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D (2014) Control Network Protocol
Specification

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 C62.45 (2002; R 2008) Recommended Practice on
Surge Testing for Equipment Connected to
Low-Voltage (1000v and less)AC Power
Circuits

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

- ISO 8802-3 (2000) Information Technology -
Telecommunications and Information
Exchange Between Systems - Local and
Metropolitan Area Networks - Specific
Requirements - Part 3: Carrier Sense
Multiple Access with Collision Detection
(CSMA/CD)Access Method and Physical Layer
Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 70 (2023) National Electrical Code
- NFPA 72 (2022; ERTA 22-1) National Fire Alarm and
Signaling Code
- NFPA 90A (2021) Standard for the Installation of
Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

- SMACNA 1966 (2020) HVAC Duct Construction Standards
Metal and Flexible, 4th Edition

UNDERWRITERS LABORATORIES (UL)

- UL 1449 (2021) UL Standard for Safety Surge
Protective Devices
- UL 506 (2017; Reprint Jan 2022) UL Standard for
Safety Specialty Transformers
- UL 508A (2013; Reprint Jan 2014) Industrial
Control Panels
- UL 916 (2015; Reprint Oct 2021) UL Standard for
Safety Energy Management Equipment

1.2 DEFINITIONS

1.2.1 ANSI/ASHRAE Standard 135

ANSI/ASHRAE Standard 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks, referred to as "BACnet". ASHRAE developed BACnet to provide a method for diverse building automation devices to communicate and share data over a network.

1.2.2 ARCNET

NOT USED

1.2.3 BACnet

Building Automation and Control Network; the common name for the communication standard [ASHRAE 135](#). The standard defines methods and protocol for cooperating building automation devices to communicate over a variety of LAN technologies.

1.2.4 BACnet/IP

An extension of BACnet, Annex J, defines this mechanism using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number. See also "BACnet Broadcast Management Device".

1.2.5 BACnet Internetwork

Two or more BACnet networks, possibly using different LAN technologies, connected with routers. In a BACnet internetwork, there exists only one message path between devices.

1.2.6 BACnet Network

One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.

1.2.7 BACnet Segment

One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.

1.2.8 BBMD

BACnet Broadcast Management Device (BBMD). A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Every IP subnetwork that is part of a BACnet/IP network must have only one BBMD. See also "BACnet/IP".

1.2.9 BAS

Building Automation Systems, including DDC (Direct Digital Controls) used for facility automation and energy management.

1.2.10 BAS Owner

The regional or local user responsible for managing all aspects of the BAS

operation, including: network connections, workstation management, technical support, control parameters, and daily operation. The BAS Owner for this project is **Camp Lejeune Public Works**.

1.2.11 BIBBs

BACnet Interoperability Building Blocks. A collection of BACnet services used to describe supported tasks. BIBBs are often described in terms of "A" (client) and "B" (server) devices. The "A" device uses data provided by the "B" device, or requests an action from the "B" device.

1.2.12 BI

BACnet International, formerly two organizations: the BACnet Manufacturers Association (BMA) and the BACnet Interest Group - North America (BIG-NA).

1.2.13 BI/BTL

BACnet International/BACnet Testing Laboratories (Formerly BMA/BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.

1.2.14 Bridge

Network hardware that connects two or more network (or BACnet internetwork) segments at the physical and data link layers. A bridge may also filter messages.

1.2.15 Broadcast

A message sent to all devices on a network segment.

1.2.16 Device

Any control system component, usually a digital controller, that contains a BACnet Device Object and uses BACnet to communicate with other devices. See also "Digital Controller".

1.2.17 Device Object

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.

1.2.18 Device Profile

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE Standard 135-2004, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing BIBBs supported.

1.2.19 Digital Controller

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control

functions. In most cases, synonymous with a BACnet device described in this specification. See also "Device".

1.2.19.1 Terminal Device Controllers

Terminal device controllers typically are controllers with less control features, may have integrated actuators, and may be mounted directly on equipment (with enclosures).

1.2.19.2 Field Controllers

Field controllers typically have a greater capability for input/output and customization, do not have integral actuators, are mounted in an enclosure not on the equipment and are used for equipment such as VAV air handlers.

1.2.19.3 Plant Controllers

Plant controllers are typically used to control various equipment in mechanical rooms such as pumps, heat exchangers, and chillers.

1.2.19.4 Supervisory Building Controller (SBC)

The Supervisory Building Controller is used to coordinate all equipment in a building, input scheduling, and is used as a connection point for transferring configuration files to the other controllers. The SBC shall communicate with other controllers and equipment through a BACnet MS/TP bus. Depending on approvals and capabilities, the SBC may be used as a point of connection between the Camp Lejeune EMCS network (IP) and the building level control network (BACnet MS/TP).

1.2.20 Direct Digital Control (DDC)

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.

1.2.21 DDC System

A network of digital controllers, communication architecture, and user interfaces. A DDC system may include programming, sensors, actuators, switches, relays, factory controls, operator workstations, and various other devices, components, and attributes.

1.2.22 Energy Management & Control System (EMCS)

The EMCS at Camp Lejeune is an enterprise system that actively receives energy and building condition information from multiple sources and provides load shedding, electric metering, alarming, trending, scheduling, set point adjustment and device status of all supervisory building controllers for maintenance personnel. The EMCS receives real time electrical utility pricing data and automatically manages to Camp Lejeune's energy target. The existing EMCS consists of two servers, 1) Johnson Controls Incorporated (JCI) Metasys Extended Architecture (ADX server), and 2) Niagara FX N4 supervisor (JCI FX web supervisor). Both of the systems communicate over the MCEN and either may be used to fulfill the requirements of this specification.

1.2.23 Ethernet

A family of local-area-network technologies providing high-speed networking features over various media.

1.2.24 Firmware

Software programmed into read only memory (ROM), flash memory, electrically erasable programmable read only memory (EEPROM), or erasable programmable read only memory (EPROM) chips.

1.2.25 Gateway

Communication hardware and software connecting two or more different protocols, similar to human language translators. The Gateway translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a Gateway has BACnet on one side and non-BACnet protocols on the other side.

1.2.26 Global ID

An identification number assigned to each Supervisory Building Controller. The Global ID includes assigned MSTP Trunk Instance Numbers and a range of BACnet Instance Numbers to be used for the Field Controllers. The Global ID is assigned by Public Works.

1.2.27 Half Router

A device that participates as one partner in a BACnet point-to-point (PTP) connection. Two half-routers in an active PTP connection combine to form a single router.

1.2.28 Hub

A common connection point for devices on a network.

1.2.29 Internet Protocol (IP, TCP/IP, UDP/IP)

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 "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.2.30 Input/Output (I/O)

Physical inputs and outputs to and from a device, although the term sometimes describes software, or "virtual" I/O. See also "Points".

1.2.31 I/O Expansion Unit

An I/O expansion unit provides additional point capacity to a digital controller.

1.2.32 IP subnet

Internet protocol (IP) identifies individual devices with a 32-bit number divided into four groups from 0 to 255. Devices are often grouped and share some portion of this number. For example, one device has IP address 209.185.47.68 and another device has IP address 209.185.47.82. These two devices share Class C subnet 209.185.47.00

1.2.33 Local-Area Network (LAN)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.2.34 LonTalk

CEA-709.1-D. A communication protocol developed by Echelon Corp. LonTalk is **not permitted**.

1.2.35 MAC Address

Media Access Control address. The physical node address that identifies a device on a Local Area Network.

1.2.36 Master-Slave/Token-Passing (MS/TP)

ISO 8802-3. One of the LAN options for BACnet. MSTP uses twisted-pair wiring for relatively low speed and low cost communication (up to 4,000 ft at 76.8K bps).

1.2.37 Native BACnet Device

A device that uses BACnet as its primary, if not only, method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.

1.2.38 Network

Communication technology for data communications. BACnet approved network types are BACnet over Internet Protocol (IP), Point to Point (PTP) Ethernet, MS/TP, and LonTalk®. **In general, networks within the building, all controllers and equipment will be BACnet MS/TP, unless noted otherwise.**

1.2.39 Network Number

A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.

1.2.40 Object

The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.

1.2.41 Object Identifier

An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.

1.2.42 Object Properties

Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in [ASHRAE 135](#); some are optional and some are required. Objects are controlled by reading from and writing to object properties.

1.2.43 Peer-to-Peer

Peer-to-peer refers to devices where any device can initiate and respond to communication with other devices. [Peer-to-Peer configurations must be reviewed and approved by Camp Lejeune Public Works Department.](#)

1.2.44 Performance Verification Test (PVT)

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.

1.2.45 PID

Proportional, integral, and derivative control; three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.2.46 PICS

Protocol Implementation Conformance Statement (PICS), describing the BACnet capabilities of a device. See BACnet, Annex A for the standard format and content of a PICS statement.

1.2.47 Points

Physical and virtual inputs and outputs. See also "Input/Output".

1.2.48 PTP

Point-to-Point protocol connects individual BACnet devices or networks using serial connections like modem-to-modem links.

1.2.49 Repeater

A network component that connects two or more physical segments at the physical layer.

1.2.50 Router

[A BACnet router is a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN. If a router is connected directly to the MCEN, it must be listed on the approved DIACAP equipment list and must be Marine Corps DADMS listed and approved.](#)

1.2.51 Stand-Alone Control

Refers to devices performing equipment-specific and small system control without communication to other devices or computers for physical I/O,

excluding outside air and other common shared conditions. Devices are located near controlled equipment, with physical input and output points limited to 64 or less per device, except for complex individual equipment or systems. Failure of any single device or communications will not cause other network devices to fail. Internal time clocks and onboard scheduling are required to allow for stand-alone control if not connected to a Supervisory Building Controller. BACnet "Smart" actuators (B-SA profile) and sensors (B-SS profile) communicating on a network with a parent device are exempt from stand-alone requirements. Provide stand-alone control routines to provide for energy saving sequences such as free cooling. Provide stand-alone control routines that operate without connection to the BACnet/IP and MS/TP networks during a loss of communication.

1.2.52 Supervisory Building Controller

Supervisory Controller that is the main interface for the building control system.

1.3 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section in accordance with the paragraph SUBCONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00 ADMINISTRATIVE REQUIREMENTS. The paragraph specifies that all contract requirements of this section shall be accomplished directly by a first tier subcontractor. No work required shall be accomplished by a second tier subcontractor.

1.4 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC DESCRIPTION

- a. Provide entire new BACnet DDC system(s) including associated equipment and accessories.
- b. All new devices are accessible using a Web browser interface and communicate using ASHRAE 135 BACnet communications without the use of gateways, unless gateways are shown on the design drawings and specifically requested by the Government. Where gateways are allowed, they must support ASHRAE 135, including all object properties and read-write services shown on Government approved interoperability schedules. Manufacturer's products, including design, materials, fabrication, assembly, inspection, and testing shall be in accordance with ASHRAE 135, ASME B31.1, and NFPA 70, except where indicated otherwise.

1.4.1 Design Requirements

1.4.1.1 Control System Drawings Title Sheet

Provide a title sheet for the control system drawing set. Include the project title, project location, contract number, the controls contractor preparing the drawings, an index of the control drawings in the set, and a legend of the symbols and abbreviations used throughout the control system drawings. The Title Block of each drawing must include the Drawing revision, i.e. Submittal, Revision 1, Revision 2, As-Built, etc., including the date.

1.4.1.2 List of I/O Points

Also known as a Point Schedule, provide for each input and output point physically connected to a digital controller: point name, point

description, point type (Analog Output (AO), Analog Input (AI), Binary Output (BO), Binary Input (BI)), point sensor range, point actuator range, point address, BACnet object, associated BIBBS (where applicable), and point connection terminal number and cable type (18/2, 18/3, etc). Typical schedules for multiple identical equipment are allowed unless otherwise requested in design or contract criteria. All points shall adhere to the Camp Lejeune Standard naming conventions.

1.4.1.3 Control System Components List

Provide a complete list of control system components installed on this project. Include for each controller and device: control system schematic name, control system schematic designation, device description, manufacturer, model, part number, firmware version, serial number, physical location (e.g. Building 4, room 112 overhead), and power requirements (i.e. AC/DC voltage and power draw). For sensors, include point name, sensor range, and operating limits. For valves, include body style, Cv, design flow rate, pressure drop, valve characteristic (linear or equal percentage), and pipe connection size. For actuators, include point name, spring or non-spring return, modulating or two-position action, normal (power fail) position, nominal control signal operating range (0-10 volts DC or 4-20 milliamps), and operating limits.

1.4.1.4 Control System Schematics

Provide control system schematics. Typical schematics for multiple identical equipment are allowed unless otherwise requested in design or contract criteria. Include the following:

- a. Location of each input and output device, specify room # for remote devices.
- b. Flow diagram for each piece of HVAC equipment
- c. Name or symbol for each control system component, such as V-1 for a valve
- d. Setpoints, with differential or proportional band values
- e. Written sequence of operations for the HVAC equipment
- f. Valve and Damper Schedules, with normal (power fail) position
- g. Control cabinet general layout, include all devices, point count, cable type (18/2, 18/3, etc), 24VAC VA power requirement for all devices including those powered from the cabinet.

1.4.1.5 HVAC Equipment Control Ladder Diagrams

Provide HVAC equipment control ladder diagrams. Indicate required electrical interlocks. Ladder diagram schematics shall include 120 VAC and low voltage devices in each panel. Ladder diagram schematics shall also include all field devices (sensors, relays, actuators, etc.) and any connection point to controlled equipment or devices.

1.4.1.6 Component Wiring Diagrams

Provide a wiring diagram for each type of input device and output device.

Indicate how each device is wired and powered; showing typical connections at the digital controller and power supply. Show for all field connected devices such as control relays, motor starters, actuators, sensors, and transmitters.

1.4.1.7 Terminal Strip Diagrams

Provide a diagram of each terminal strip. Indicate the terminal strip location, termination numbers, and associated point names.

1.4.1.8 BACnet Communication Architecture Schematic(Network Riser)

Provide a schematic showing the project's entire BACnet communication network complete with wire sizes, including Internet Protocol (IP), Media Access Control (MAC), BACnet network, Device ID, field bus address, BBMDs, any devices using BACnet FDR, and Firmware version / Operating System, LAN devices including routers and bridges, gateways, controllers, workstations, and field interface devices. If applicable, show connection to existing networks and include the existing network in the riser diagram. Include surge protection device at all locations on the riser when the field controller communication trunk is leaving or entering a building and at all external equipment (such as chillers) .

1.4.1.9 Control Panel Layout

Provide a detailed panel layout for each control panel, relay panel, etc. The layout shall include all components to be installed in the panel including controllers, terminal strips, transformers, wireway, etc.

1.5 SUBMITTALS

Submit detailed and annotated manufacturer's data, drawings, and specification sheets for each item listed, that clearly show compliance with the project specifications.

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 Notebook, 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

Include the following in the project's control system drawing set:

Control System Drawings Title Sheet; G

List of I/O Points; G

Control System Components List; G

Control System Schematics; G

HVAC Equipment Control Ladder Diagrams; G

Component Wiring Diagrams; G

Terminal Strip Diagrams; G

BACnet Communication Architecture Schematic (Network Riser)

Sequence of Operations

Control Panel Layout

SD-03 Product Data

Direct Digital Controllers; G

Include BACnet PICS for each controller/device type, including smart sensors (B-SS) and smart actuators (B-SA).

BACnet Gateways; G

Include BACnet and workstation display information; bi-directional communication ability; compliance with interoperability schedule; expansion capacity; handling of alarms, events, scheduling and trend data; and single device capability (not depending on multiple devices for exchanging information from either side of the gateway).

Notebook Computer Software; G

Include BACnet PICS for Operator Workstation software.

Notebook Computer; G

Sensors and Input Hardware; G

Output Hardware; G

Surge and Transient Protection; G

Indicators; G

Duct smoke detectors; G

Variable Frequency (Motor) Drives; G

SD-05 Design Data

Performance Verification Testing Plan; G

Pre-Performance Verification Testing Checklist; G

SD-06 Test Reports

Performance Verification Testing Report; G

Bus Waveform Report; G

SD-07 Certificates

Contractor's Qualifications; G

Contractor's Training Certifications; G

SD-10 Operation and Maintenance Data

Comply with requirements for data packages in Section 01 78 23
OPERATION AND MAINTENANCE DATA and in Section 01 78 24.00 20
FACILITY ELECTRONIC OPERATION AND MAINTENANCE SUPPORT INFORMATION
(eOMSI), except as supplemented and modified in this specification.

BACnet Direct Digital Control Systems, Data Package 4; G

Controls System Operators Manuals, Data Package 4; G

VFD Service Manuals, Data Package 4; G

SD-11 Closeout Submittals

Training Documentation; G

Warranty Information; G

1.6 QUALITY ASSURANCE

1.6.1 Standard Products

Provide material and equipment that are standard manufacturer's products currently in production and supported by a local service organization.

1.6.2 Delivery, Storage, and Handling

Handle, store, and protect equipment and materials to prevent damage before and during installation according to manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6.3 Operating Environment

Protect components from humidity and temperature variation, dust, and contaminants. If components are stored before installation, keep them within the manufacturer's limits.

1.6.4 Finish of New Equipment

New equipment finishing shall be factory provided. Manufacturer's standard factory finishing shall be proven to withstand 125 hours in a salt-spray fog test. Equipment located outdoors shall be proven to withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be according to ASTM B117, with acceptance criteria as follows: immediately after completion of the test, the finish shall show no signs of degradation or loss of adhesion beyond 0.125 inch on either side of the scratch mark.

1.6.5 Verification of Dimensions

The contractor shall verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing work.

1.6.6 Contractor's Qualifications

Submit documentation certifying the controls Contractor performing the

work has completed at least three DDC systems installations of a similar design to this project, and programmed similar sequences of operation for at least two years. Personnel performing the installation, programming, checkout, commissioning and training shall, at a minimum, have obtained all certifications required by the manufacturer for the tasks they are performing. Tasks include any activity required to execute and complete the contracted work. Certifications for each person shall be submitted prior to the beginning of the contracted work. Certifications shall be made available at any time upon the request from Camp Lejeune.

1.6.7 Modification of References

The advisory provisions in ASME B31.1, NFPA 70 and the manufacturer's recommendations are mandatory. Substitute "shall" for "should" wherever it appears and interpret all references to the "authority having jurisdiction" and "owner" to mean the Contracting Officer.

1.6.8 Project Sequence

The control system work for this project shall proceed in the following order:

- a. Preparatory meeting for controls work.
- b. Submit and receive approval on the Shop Drawings, Product Data, and Certificates specified under the paragraph SUBMITTALS>
- c. Submit and receive approval for Performance Verification Testing (PVT) Plan.
- d. DDC Pre-Installation Meeting - Contractor shall provide minimum fifteen days notice to COTR when scheduling pre-installation meeting.
- e. Perform the control system installation work, including all field check-outs and tuning.
- f. Overhead Inspection.
- g. Provide support to TAB personnel as specified under the paragraph TEST AND BALANCE SUPPORT.
- h. Submit and receive approval of the Controls System Operators Manual specified under the paragraph CONTROLS SYSTEM OPERATORS MANUALS.
- i. Perform the Performance Verification Testing.
- j. Submit and receive approval on the PVT Report. Submit As-Built Control Drawings
- k. PVT Report Acceptance test for Season 1.
- l. Submit and receive approval on the Training Documentation specified under the paragraph INSTRUCTION TO GOVERNMENT PERSONNEL and VFD Service Support. Submit at least 30 days before training.
- m. Deliver the final Controls System Operators Manuals and VFD Service Manuals.

- n. Conduct the Phase I Training and VFD on-site/hands-on training.
- o. Conduct the Phase II Training.
- p. Submit and receive approval of Closeout Submittals.
- q. PVT Report Acceptance Test for Season 2.

PART 2 PRODUCTS

2.1 DDC SYSTEM

- a. Provide a networked DDC system for stand-alone control in compliance with the latest revision of the ASHRAE 135 BACnet standard. Include all programming, objects, and services required to meet the sequence of control. Provide BACnet MS/TP communications between the DDC system and native BACnet devices furnished with HVAC equipment and plant equipment including boilers, chillers, and variable frequency drives. Devices provided shall be certified in the BACnet Testing Laboratories (BTL) Product Listing and in accordance with ASHRAE 135.1 Method of Test for Conformance to BACnet. Controls provided integral to equipment shall be part of the DDC system and shall fully comply with this specification. Coordinate integration of integral controls into the system as a whole. BACnet over IP is not permitted within the DDC system.
- b. Assist the Government in interfacing the new DDC system with the site's existing server and operator workstation and software. Create graphics, scheduling, alarming, and trending.

2.1.1 Supervisory Building Controller (SBC)

ASHRAE 135 building controller that is the main interface for the building control system. Provide either a Johnson Controls Incorporated NAE, NCE, SNE or SNC; OR a JACE based on the Niagara N4 platform. The JACE (JAVA Application Control Engine) shall be minimally based on a Tridium 8000 with expanded memory and embedded "Niagara Workbench or Workplace" software.

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 Compatibility 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) Two 10/100/1000 Mbps Ethernet Port(s)
- (2) One or more MS/TP ports.
- (3) Central Processing Unit of 1000 Mhz or higher.
- (4) Embedded operating system.

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 all projects.

g. Submit a backup of each Niagara Framework Supervisory Gateway. 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.

2.1.1.1 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.

2.1.1.2 Supervisory Controller MCEN Network Homerun

See UFGS 27 10 00 and CLGS 27 10 00 for requirements

2.1.2 EMCS Interface

The Energy Management & Control System (EMCS) at Camp Lejeune is comprised of two separate systems. Both of the systems communicate over the basewide Marine Corps Enterprise Network (MCEN). One uses the Johnson Controls Network Automation Engine (NAE), Network Control Engine (NCE), Supervisory Network Engine (SNE) or Supervisory Network Control Engine (SNC) to the ADX server. The second system uses a Niagara FX N4 web supervisor with a JACE in the building communicating using Fox protocol. Because of IT security and permissions, only these systems and equipment are permitted as part of the EMCS.

2.1.2.1 Supervisory Building Controller

Provide either a Johnson Controls NAE, NCE, SNE, SNC or a JACE. This will serve as both the Supervisory Building Controller and the connection point between the buildings DDC and the EMCS. Provide a five year service license on all Supervisory Controllers. Provide a reserve of 10% of additional points and additional devices on the Supervisory Controller license at the final project acceptance.

The contractor shall assign Camp Lejeune Public Works Department as the owner and manager of all licenses including 3rd party drivers.

2.1.2.2 Palo Alto Firewall

For any building provided with a new Supervisory controller, contractor shall also provide a Palo Alto Firewall Model PAN-PA-220R. Contractor shall also provide a five year government support option for the Palo Alto firewall complete with all licenses.

2.1.3 Direct Digital Controllers

Direct digital controllers shall be **UL 916** rated.

DDC Field Controllers:

Acceptable DDC field controllers are Facility Explorer, Metasys or Distech.

2.1.3.1 I/O Point Limitation

The total number of I/O hardware points used by a single stand-alone digital controller, including I/O expansion units, shall not exceed 64, except for complex individual equipment or systems. Place I/O expansion units in the same cabinet as the digital controller. The field controller must have one spare Configurable Output and one spare Universal Input available per system upon project completion, i.e. AHU, ERU, DOAS, HW System, CHW System and other building primary systems. VAV controllers and programmable thermostats are excluded.

2.1.3.2 Environmental Limits

Controllers shall be suitable for, or placed in protective enclosures suitable for the environment (temperature, humidity, dust, and vibration) where they are located.

2.1.3.3 Stand-Alone Controllers

Provide stand-alone direct digital controllers with internal time clocks **if not connected to a Supervisory Building Controller**. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of any building communication failure. All I/O points specified for a piece of equipment shall be integral to its controller and serial connected expansion modules. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

2.1.3.4 Internal Clock

Provide internal clocks and scheduling for all Direct Digital Controllers. Provide controllers with BTL listed profiles for all BACnet Building Controllers (B-BC) and BACnet Advanced Application Controllers (B-AAC) using BACnet time synchronization services. This includes but is not limited to VAV Controllers, Fan Coil controllers, Heat Pump controllers and any terminal controllers. BACnet Application specific controllers (B-ASC) will only be accepted for dedicated small exhaust system control such as restroom and mechanical room exhaust fans. Automatically synchronize system clocks daily from an operator-designated controller. The system shall automatically adjust for daylight saving time.

2.1.3.5 Memory

Provide sufficient memory for each controller to support the required control, communication, trends, alarms, and messages. Protect programs residing in memory with EEPROM, flash memory, or by an uninterruptible power source (battery or uninterruptible power supply). The backup power source shall have capacity to maintain the memory during a 72-hour continuous power outage. Rechargeable power sources shall be constantly charged while the controller is operating under normal line power. Batteries shall be replaceable without soldering. Trend and alarm history collected during normal operation shall not be lost during power outages less than 72 hours long.

2.1.3.6 Immunity to Power Fluctuations

Controllers shall operate at 90 percent to 110 percent nominal voltage rating.

2.1.3.7 Transformer

The controller power supply shall be fused or current limiting and rated at 125 percent power consumption. Each transformer must singularly serve the connected load, i.e. do not wire transformers in parallel on the load side. **Transformer shall be mounted in the upper portion of the control panel to aid in heat dissipation. The 120 volt power feed must also enter in the upper portion of the cabinet - power shall not be brought in from the**

bottom of the panel.

2.1.3.8 Wiring Terminations

Use screw terminal wiring terminations for all field-installed controllers. Provide field-removable modular terminal strip or a termination card connected by a ribbon cable for all controllers other than terminal units.

2.1.3.9 Input and Output Interface

Provide hard-wired input and output interface for all controllers as follows:

- a. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with sources up to 24 volts AC or DC for any duration shall cause no controller damage.
- b. Binary Inputs: Binary inputs shall monitor on and off contacts from a "dry" remote device without external power, and external 5-24 VDC voltage inputs.
- c. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and accumulate pulses at a resolution suitable to the application.
- d. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 VDC), current (4-20 mA), or resistance (thermistor or RTD) signals.
- e. Binary Outputs: Binary outputs shall send a pulsed 24 VDC low-voltage signal for modulation control, or provide a maintained open-closed position for on-off control. Where appropriate, provide a method to select normally open or normally closed operation.
- f. Analog Outputs: Analog outputs shall send modulating 0-10 VDC or 4-20 mA signals to control output devices.
- g. Tri-State Outputs: Tri-State outputs shall provide three-point floating control of terminal unit electronic actuators.

2.1.3.10 Digital Controller BACnet Internetwork

Provide intermediate gateways, only when requested by the Government and shown on the contract drawings, to connect existing non-BACnet devices to the BACnet internetwork. Controller and operator interface communication shall conform to [ASHRAE 135](#), BACnet. If a controller becomes non-responsive, the remaining controllers shall continue operating and not be affected by the failed controller.

2.1.3.11 Communications Ports

- a. Direct-Connect Interface Ports: Provide at least one extra communication port at each local BACnet network for direct connecting a notebook computer or BACnet hand-held terminal so all network BACnet objects and properties may be viewed and edited by the operator.

2.1.3.12 BACnet Gateways

Provide BACnet communication ports, whenever available as a plant equipment OEM standard option, for DDC integration via a single communication cable. Typical BACnet controlled plant equipment includes, but is not limited to, boilers, chillers, and variable frequency motor drives.

Provide gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC controlled plant equipment, only when specifically requested and approved by the Government, and shown on the Government approved BACnet Communication Architecture Schematic. Provide with each gateway an interoperability schedule, showing each point or event on the legacy side that the BACnet "client" will read, and each parameter that the BACnet network will write to. Describe this interoperability in terms of BACnet services, or Interoperability Building Blocks (BIBBS), defined in [ASHRAE 135](#) Annex K. Provide two-year minimum warranty for each gateway, including parts and labor.

The following minimum capabilities are required:

- a. [Gateways](#) shall be able to read and view all readable object properties listed in the interoperability schedule on the non-BACnet network to the BACnet network and vice versa where applicable.
- b. [Gateways](#) shall be able to write to all writeable object properties listed in the interoperability schedule on the non-BACnet network from the BACnet network and vice versa where applicable.
- c. [Gateways](#) shall provide single-pass (only one protocol to BACnet without intermediary protocols) translation from the non-BACnet protocol to BACnet and vice versa.
- d. [Gateways](#) shall meet the requirements of Data Sharing Read Property (DS-RP-B), Data Sharing Write Property (DS-WP-B), Device Management Dynamic Device Binding-B (DM-DDB-B), and Device Management Communication Control (DM-DCC-B) BIBBs, in accordance with [ASHRAE 135](#).
- e. [Gateways](#) shall include all hardware, software, software licenses, and configuration tools for operator-to-gateway communications. Provide backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

2.1.3.13 Digital Controller Cabinet

Provide each digital controller including gateways, in a factory fabricated [locked](#) cabinet enclosure.

Cabinets located indoors shall protect against dust and have a minimum NEMA 1 rating, except where indicated otherwise. Cabinets located outdoors or in damp environments shall protect against all outdoor conditions and have a minimum NEMA 4 rating. [Mechanical rooms that contain steam service or equipment including new steam boiler rooms are considered damp environments.](#) Outdoor control panels and controllers must be able to withstand extreme ambient conditions, without malfunction or failure, whether or not the controlled equipment is running. If necessary, provide a thermostatically controlled panel heater in freezing locations, and an internal ventilating fan in locations exposed to direct

sunlight. Cabinets shall have a hinged lockable door and an offset removable metal back plate, except controllers integral with terminal units, like those mounted on VAV boxes. Provide like-keyed locks for all hinged panels provided and a set of two keys at each panel, with one key inserted in the lock. All devices must be mounted only to the cabinet backplane with adequate space allowed for serviceability and proper heat dissipation from devices. The Supervisory controller cabinet door position (closed/open) shall be monitored with a door switch and BACnet programmable relay such as the Functional Devices RIBTW2401B-BC. An "open" door status shall initiate an alarm to the EMCS Server.

2.1.3.14 Main Power Switch and Receptacle

Provide each control cabinet with a main external power on/off switch located inside the cabinet. Also provide each cabinet with a separate 120 VAC duplex convenience receptacle.

2.1.4 DDC Software

2.1.4.1 Programming

Provide programming to execute the sequence of operation indicated. Provide all programming, tools, interfaces, cables, etc. to configure and program all controllers. All software shall be licensed to Marine Corps Base, Camp Lejeune Complex for unrestricted use on Camp Lejeune Complex and reproduction for use on Camp Lejeune Complex. Software keys and "dongles" are not permitted. Provide programming routines in simple, easy-to-follow logic with detailed text comments describing what the logic does and how it corresponds to the project's written sequence of operation. All logic programming and control functions shall be closed loop, command and feedback for fault detection and alarming when status != command.

- a. Graphic-based programming shall use a library of function blocks made from pre-programmed code designed for BAS control. Function blocks shall be assembled with interconnecting lines, depicting the control sequence in a flowchart. If providing a computer with device programming tools as part of the project, graphic programs shall be viewable in real time showing present values and logical results from each function block.
- b. Menu-based programming shall be done by entering parameters, definitions, conditions, requirements, and constraints.
- c. For line-by-line and text-based programming, declare variable types (variable types include but are not limited to the following: local, global, real, and integer) at the beginning of the program. Use descriptive comments frequently to describe the programming.
- d. If providing a computer with device programming tools as part of the project, provide a means for detecting program errors and testing software strategies with a simulation tool. Simulation may be inherent within the programming software suite, or provided by physical controllers mounted in a NEMA 1 test enclosure. The test enclosure shall contain one dedicated controller of each type provided under this contract, complete with power supply and relevant accessories.

2.1.4.2 Parameter Modification

All writeable object properties, and all other programming parameters needed to comply with the project specification shall be adjustable for devices at any network level, including those accessible with web-browser communication, and regardless of programming methods used to create the applications.

2.1.4.3 Short Cycling Prevention

Provide setpoint differentials and minimum on/off times to prevent equipment short cycling.

2.1.4.4 Equipment Status Delay

Provide an adjustable delay from when equipment is commanded on or off and when the control program looks to the status input for confirmation.

2.1.4.5 Run Time Accumulation

Use the Elapsed Time Property to provide re-settable run time accumulation for each Binary Output Object connected to mechanical loads greater than 1 HP, electrical loads greater than 10 KW, or wherever else specified.

2.1.4.6 Timed Local Override

Provide an adjustable override time for each push of a timed local override button.

2.1.4.7 Time Synchronization

Provide time synchronization, including adjustments for leap years, daylight saving time, and operator time adjustments.

2.1.4.8 Scheduling

Provide operating schedules as indicated, with equipment assigned to groups. Changing the schedule of a group shall change the operating schedule of all equipment in the group. Groups shall be capable of operator creation, modification, and deletion. Provide capability to view and modify schedules in a seven-day week format. Provide capability to enter holiday and override schedules one full year at a time.

2.1.4.9 Object Property Override

Allow writeable object property values to accept overrides to any valid value. Where specified or required for the sequence of control, the Out-Of-Service property of Objects shall be modifiable using BACnet's write property service. When documented, exceptions to these requirement are allowed for life, machine, and process safeties.

2.1.4.10 Alarms and Events

Alarms and events shall be capable of having programmed time delays and high-low limits. When a web server is connected to the BACnet internetwork, alarms/events shall report to [web server](#) as defined by an authorized operator. Otherwise alarms/events shall be stored within a device on the BACnet network until connected to a user interface device and retrieved. Provide alarms/events in agreement with the point

schedule, sequence of operation, and the BAS Owner. At a minimum, provide programming to initiate alarms/events any time a piece of equipment fails to operate, a control point is outside normal range or condition shown on schedules, communication to a device is lost, a device has failed, or a controller has lost its memory.

2.1.4.11 Trending

Provide BACnet trending all object present values, set points, and other parameters indicated for trending on project schedules **or at the request of Camp Lejeune or commissioning agents**. Trends may be associated into groups, and a trend report may be set up for each group. Trends are stored within a device on the BACnet network, with operator selectable trend intervals from 10 seconds up to **24 hours**. The minimum number of consecutive trend values stored at one time shall be 100 per variable. When trend memory is full, the most recent data shall overwrite the oldest data.

The BACnet system shall allow for Change-Of-Value (COV) subscription based trending at user defined thresholds.

The **B-BC** shall upload trends automatically upon reaching 3/4 of the device buffer limit (via Notification_Threshold property), by operator request, or by time schedule for archiving. Archived and real-time trend data shall be available for viewing numerically and graphically for at the workstation and connected notebook computers.

Additionally, provide daily trend on geothermal well field supply and return temperatures. Allocate sufficient memory to store 24 months data.

2.1.4.12 Device Diagnostics

Each controller shall have diagnostic LEDs for power, communication, and device fault condition. The DDC system shall recognize and report a non-responsive controller.

2.1.4.13 Power Loss

Upon restoration of power, the DDC system shall perform an orderly restart and restoration of control.

2.1.5 Notebook Computer

Provide a notebook computer, complete with the project's installed DDC software, applications database, **final archived field controller programs and Supervisory controller database**, and graphics to fully troubleshoot and program the project's devices. Provide the notebook computer with a **ballistic** nylon carrying case with shoulder strap, **or backpack**, and all necessary cables and interface hardware needed for **setup and direct communication with the controllers and control system components**. **Direct communication shall not be through the Supervisory controller.**

At a minimum the notebook computer shall include: **Common Access Card Reader**, Windows **based** operating system, minimum 2.7 GHz processor **base speed** with 3 MB Cache, discrete switchable graphics card with minimum 1 GB dedicated memory, 1 Terabyte hard drive, **32 GB DDR3 RAM**, 2 USB 3.0 ports, 10/100/1000 network interface card, 802.11 b/g/n WLAN, 17-inch display, keyboard with numeric keypad, 6-hour battery with charger, **internal or external 8X DVD+/-R/RW drive** with double layer support with DVD creator

software, and Microsoft Office Home and Business bundled software. Provide all original licenses, installation media, documentation, and recovery CDs capable of restoring the original configuration. Provide a means to connect the notebook computer **directly to the installed field bus**. Provide the manufacturer's 3-year accidental damage protection with 3-day on site response for 2 year warranty with the Government listed as the warranty owner.

2.1.6 Notebook Computer Software

2.1.6.1 Password Protection

System shall support role based access. At a minimum OS administrator, auditor, DDC operator and user roles must be defined. The system must be capable of enforcing role based access by location (e.g., Bob may alter operating parameters for Building 1 but not Building 2. Building 2 is Alice's responsibility).

Workstation shall be capable of DoD Common Access Card (CAC) login in addition to traditional username and password.

The lowest level only allow viewing graphics. The second level allows viewing graphics and changing space temperature setpoints. The third level allows the previous level's capability, plus changing operating schedules. The fourth level allows access to all functions except passwords. The highest level provides all administrator rights and allows full access to all programming, including setting new passwords and access levels. Provide the BAS Owner with the highest level password access. Provide automatic log out if no keyboard or mouse activity is detected after a user-defined time delay.

2.1.6.2 Notebook Computer DDC Software

Provide the workstation software with the manufacturer's installation CDs and licenses. Configure the software according to the DDC system manufacturer's specifications, cybersecurity requirements, and in agreement with BACnet Operator Workstation (B-OWS) device standards found in ASHRAE 135, Annex L.

The workstation software shall permit complete monitoring, modification, **archiving, programming** and troubleshooting interface with the DDC system **including supervisory controller and field controllers**. **Software shall include, but not limited to, Niagara Workplace, FX Workbench, JCI SCT, CCT/PCT, Distech EC-gfx or any controls manufacturer Supervisory controller and field controller programming software used to program the system**. The operator interface with the software shall be menu-driven with appropriate displays and menu commands to manipulate the DDC system's objects, point data, operating schedules, control routines, system configuration, trends, alarms, messages, graphics, and reports. Trends shall be capable of graphic display in real time, with variables plotted as functions of time. Each alarmed point shall be capable of displaying its alarm history, showing when it went into alarm, if and when it was acknowledged, and when it went out of alarm. The modification of DDC system parameters and object properties shall be accomplished with "fill in the blank" and/or "point and drag" methods. Modifications shall download to the appropriate controllers at the operator's request.

2.1.6.3 Web-Based User Interface (UI) and Graphics

Provide web-based graphics fully compatible with Internet Explorer 9+, Safari, Firefox, and Google Chrome. Web-based user interface shall be browser agnostic and shall not rely on proprietary client side scripting to function.

Graphic displays shall have full-screen resolution when viewed on the workstation and notebook computers. Dynamic data on graphics pages shall refresh within 10 seconds using an Internet connection, or 30 seconds using a dial-up modem connection. Web-based user interface shall not rely on additional third-party browser "plug-in" software like Adobe Flash. Java client side applets may be used if appropriately signed. If Java client side runtimes are used they shall not require deprecated or otherwise unsupported Java runtime environments.

The graphics shall show the present value and object name for each of the project's I/O points on at least one graphic page. Arrange point values and names on the graphic displays in their appropriate physical locations with respect to the floor plan or equipment graphic displayed. Graphics shall allow the operator to monitor current status, view zone and equipment summaries, use point-and-click navigation between graphic pages, and edit setpoints and parameters directly from the screens. Items in alarm shall be displayed using a different color or other obvious visual indicator.

Provide graphics with the following:

- a. **Graphic Types:** Provide at least one graphic display for each piece of HVAC equipment, building floor, and controlled zone. Indicate dynamic point values, operating statuses, alarm conditions, and control setpoints on each display. Provide summary pages where appropriate.

- (1) **Building Elevation:** For buildings more than one story, provide an elevation view of the building with links to each of the building's floor plans. Simulate the building's architecture and include the building number and floor numbers. If possible, use an actual photograph of the building.
- (2) **Building Floor Plans:** Provide a floor plan graphic for each of the building's floors and roof with dynamic display of space temperature and other important data. If used, indicate and provide links to sub-plan areas. If possible, use the project's electronic drawing files for the graphic backgrounds. Provide clear names for important areas, such as "Main Conference Room." Include room names and numbers where applicable. Include features such as stairwells, elevators, and main entrances. Where applicable, include the mechanical room, HVAC equipment, and control component locations, with corresponding links to the equipment graphics.
- (3) **Sub-plan Areas:** Where a building's floor plan is too large to adequately display on the screen, sub-divide the plan into distinct areas, and provide a separate graphic display for each area. Provide same level of detail requested in building floor plan section above.
- (4) **HVAC Equipment:** Provide a graphic display for each piece of HVAC equipment, such as a fan coil unit, VAV terminal, or air handling unit. Equipment shall be represented by a two or

three-dimensional drawing. Where multiple pieces of equipment combine to form a system, such as a central chiller plant or central heating plant, provide one graphic to depict the entire plant. Indicate the equipment, piping, ductwork, dampers, and control valves in the installed location. Include labels for equipment, piping, ductwork, dampers, and control valves. Show the direction of air and water flow. Include dynamic display of applicable object data with clear names in appropriate locations.

- (5) Sequence of Operation: Provide a graphic screen displaying the written out full sequence of operation for each piece of HVAC equipment. Provide a link to the sequence of operation displays on their respective equipment graphics. Include dynamic real-time data within the text for setpoints and variables.

- b. Graphic Title: Provide a prominent, descriptive title on each graphic page.
- c. Dynamic Update: When the workstation is on-line, all graphic I/O object values shall update with change-of-value services, or by operator selected discrete intervals.
- d. Graphic Linking: Provide forward and backward linking between floor plans, sub-plans, and equipment.
- e. Graphic Editing: Provide installed software to create, modify, and delete the DDC graphics. Include the ability to store graphic symbols in a symbol directory and import these symbols into the graphics.
- f. Dynamic Point Editing: Provide full editing capability for deleting, adding, and modifying dynamic points on the graphics.

2.2 SENSORS AND INPUT HARDWARE

Coordinate sensor types with the BAS Owner to keep them consistent with existing installations.

2.2.1 Field-Installed Temperature Sensors

Where feasible, provide the same sensor type throughout the project. Avoid using transmitters unless absolutely necessary.

2.2.1.1 Thermistors

Precision thermistors may be used in applications below 200 degrees F. Sensor accuracy over the application range shall be 0.36 degree F or less between 32 to 150 degrees F. Stability error of the thermistor over five years shall not exceed 0.25 degrees F cumulative. A/D conversion resolution error shall be kept to 0.1 degrees F. Total error for a thermistor circuit shall not exceed 0.5 degrees F.

2.2.1.2 Resistance Temperature Detectors (RTDs)

Provide RTD sensors with platinum elements compatible with the digital controllers. Encapsulate sensors in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (10k ohms) at 32 degrees F. Temperature sensor stability error over five years shall not exceed 0.25 degrees F cumulative. Direct connection of RTDs to digital controllers without

transmitters is preferred. When RTDs are connected directly, lead resistance error shall be less than 0.25 degrees F. The total error for a RTD circuit shall not exceed 0.5 degrees F.

2.2.1.3 Temperature Sensor Details

- a. Room Type: Provide the sensing element components within a decorative protective cover suitable for surrounding decor. Provide room temperature sensors with timed override button, setpoint adjustment lever.
- b. Duct Probe Type: Ensure the probe is long enough to properly sense the air stream temperature.
- c. Duct Averaging Type: Continuous averaging sensors shall be one foot in length for each 4 square feet of duct cross-sectional area, and a minimum length of 6 feet.
- d. Pipe Immersion Type: Provide minimum three-inch immersion. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel when used in steel piping, and brass when used in copper piping. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior.
- e. Outside Air Type: Provide the sensing element on the building's north side with a protective weather shade that positions the sensor approximately 3 inches off the wall surface, does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain.

2.2.2 Supervisory Controller MCEN Network Homerun

See UFGS 27 10 00 and CLGS 27 10 00

2.2.3 Transmitters

Provide transmitters with 4 to 20 mA or 0 to 10 VDC linear output scaled to the sensed input. Transmitters shall be matched to the respective sensor, factory calibrated, and sealed. Size transmitters for an output near 50 percent of its full-scale range at normal operating conditions. The total transmitter error shall not exceed 0.1 percent at any point across the measured span. Supply voltage shall be 12 to 24 volts AC or DC. Transmitters shall have non-interactive offset and span adjustments. For temperature sensing, transmitter drift shall not exceed 0.03 degrees F a year.

2.2.3.1 Relative Humidity Transmitters

Provide transmitters with an accuracy equal to plus or minus 3 percent from 0 to 90 percent scale, and less than one percent drift per year. Sensing elements shall be the polymer type.

2.2.3.2 Pressure Transmitters

Provide transmitters integral with the pressure transducer. Size transmitters for an output near 50 percent of its full-scale range at normal operating conditions.

2.2.4 Current Transducers

Provide current transducers to monitor motor amperage, unless current switches are shown on design drawings or point tables. Provide a VFD rated current sensor where applicable.

2.2.5 Motor Run Status

Unless otherwise noted, provide current switches to indicate run status of pumps and fans. Sensitivity of the switch on belt and coupler driven equipment should distinguish between loaded motor and unloaded motor such as a fan with a broken belt. Provide label indicating calibration date affixed to the device.

2.2.6 Pneumatic to Electric Transducers

Pneumatic to electronic transducers shall convert a 0 to 20 psig signal to a proportional 4 to 20 mA or 0 to 10 VDC signal (operator scaleable). Supply voltage shall be 24 VDC. Accuracy and linearity shall be 1.0 percent or better.

2.2.7 Air Quality Sensors

Provide power supply for each sensor.

2.2.7.1 CO2 Sensors

Provide photo-acoustic type CO2 sensors with integral transducers and linear output. The devices shall read CO2 concentrations between 0 and 2000 ppm with full scale accuracy of at least plus or minus 100 ppm.

2.2.7.2 Air Quality Sensors

Provide full spectrum air quality sensors using a hot wire element based on the Taguchi principle. The sensor shall monitor a wide range of gaseous volatile organic components common in indoor air contaminants like paint fumes, solvents, cigarette smoke, and vehicle exhaust. The sensor shall automatically compensate for temperature and humidity, have span and calibration potentiometers, operate on 24 VDC power with output of 0-10 VDC, and have a service rating of 32 to 140 degrees F and 5 to 95 percent relative humidity.

2.2.8 Input Switches

2.2.8.1 Timed Local Overrides

Provide buttons or switches to override the DDC occupancy schedule programming for each major building zone during unoccupied periods, and to return HVAC equipment to the occupied mode. This requirement is waived for zones clearly intended for 24 hour continuous operation.

2.2.8.2 Emergency Shut Down Switches (ATFP)

Anti Terrorism Force Protection emergency shut down switches must be two action to prevent accidental initiation, such as a mushroom push button with a cover.

2.2.9 Freeze Protection Thermostats

Provide special purpose thermostats with flexible capillary elements 20 feet minimum length for coil face areas up to 40 square feet. Provide longer elements for larger coils at 1-foot of element for every 4 square feet of coil face area, or provide additional thermostats. Provide switch contacts rated for the respective motor starter's control circuit voltage. Include auxiliary contacts for the switch's status condition. A freezing condition at any 18-inch increment along the sensing element's length shall activate the switch. The thermostat shall be equipped with a manual push-button reset switch so that when tripped, the thermostat requires manual resetting before the HVAC equipment can restart.

2.2.10 Air Flow Measurement Stations

Air flow measurement stations shall have an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. The velocity sensing elements shall be the RTD or thermistor type, traversing the ducted air in at least two directions. The air flow pressure drop across the station shall not exceed 0.08 inch water gage at a velocity of 2,000 fpm. The station shall be suitable for air flows up to 5,000 fpm, and a temperature range of 40 to 120 degrees F. The station's measurement accuracy over the range of 125 to 2,500 fpm shall be plus or minus 3 percent of the measured velocity. Station transmitters shall provide a linear, temperature-compensated 4 to 20 mA or 0 to 10 VDC output. The output shall be capable of being accurately converted to a corresponding air flow rate in cubic feet per minute. Transmitters shall be a 2-wire, loop powered device. The output error of the transmitter shall not exceed 0.5 percent of the measurement.

2.2.11 Air Flow Measurement for Terminal Devices

Air flow measurement for terminal devices such as variable air volume boxes, with or without fan power shall have an array of pressure sensing elements that sense total pressure and static pressure. The flow measurement shall be integral to the device controller and shall be by differential pressure sensor. The air flow shall measure flows down to 300 fpm with an accuracy of 5 percent of reading.

2.2.12 Energy Metering

2.2.12.1 Steam Meters

Steam meters shall be the vortex shedding type, with pressure compensation, a minimum turndown ratio of 10 to 1, and an output signal shall be 4-20 ma, pulsed, or BACnet MS/TP, all compatible with the DDC system.

2.2.12.2 Hot Water Solar Collector Meters

BACnet output or may be a combination of temperature sensors and water flow meter monitored by a DDC controller with the DDC system calculating the BTU transfer. Water flow can be measured by orifice or venturi meter selected for the anticipated system flow rate. Temperature sensors shall be placed in both the supply to and the return from the solar collector array.

2.2.12.3 Electrical Meters

Provide enhanced power and energy meter with built-in integrator and power supply for the CTs. Meter shall have onboard data logging capability as well as output to SBC via native BACnet MS/TP. Place meter indoors at building Main Distribution Panel (MDP). This meter shall be provided in addition to any other power meters required by Division 26 (Electrical) or Division 33 (Utilities).

Electrical meter shall monitor and trend the following points:

- Power (3-phase total & per phase): Real (kW), Reactive (kVAR), and Apparent (kVA)
- Power Factor: 3-phase average & per phase
- Present Power Demand: Real (kW), Reactive (kVAR), and Apparent (kVA)
- Peak Power Demand: Real (kW), Reactive (kVAR), and Apparent (kVA)
- Current: 3-phase average and per phase
- Voltage: Line-Line and Line-Neutral (3-phase average & per phase)
- Frequency
- Accumulated Net Energy: Real (kWh), Reactive (kVARh), and Apparent (kVAh)
- Accumulated Real Energy by phase (kWh)

2.3 OUTPUT HARDWARE

2.3.1 Control Dampers

Provide factory manufactured galvanized steel dampers where indicated. Dampers shall be opposed blade for rectangular applications 10-inches and taller, and single blade for round dampers and rectangular dampers shorter than 10-inches. Control dampers shall comply with SMACNA 1966 except as modified or supplemented by this specification. Published damper leakage rates and respective pressure drops shall have been verified by tests in compliance with AMCA 500-D requirements.

Provide damper assembly frames constructed of minimum thickness galvanized steel channels with mitered and welded corners. Damper axles shall be 0.5 inches minimum diameter plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings.

Dampers shall be rated for not less than 2000 fpm air velocity. The pressure drop through each damper when full-open shall not exceed 0.04 inches water gage at 1000 fpm face velocity. Damper assemblies in ductwork shall be constructed to meet SMACNA Seal Class "A" construction requirements.

Provide the damper operating linkages outside of the air stream, including crank arms, connecting rods, and other hardware that transmits motion from the damper actuators to the dampers, shall be adjustable. Additionally, operating linkages shall be designed and constructed to have a 2 to 1 safety factor when loaded with the maximum required damper operating force. Linkages shall be brass, bronze, galvanized steel, or stainless steel.

Provide access doors or panels in hard ceilings and walls for access to all concealed damper operators and damper locking setscrews.

For field-installed control dampers, a single damper section shall have blades no longer than 48 inches and no higher than 72 inches. The maximum

damper blade width shall be 12 inches. Larger sized dampers shall be built using a combination of sections.

Frames shall be at least 2 inches wide. Flat blades shall have edges folded for rigidity. Blades shall be provided with compressible gasket seals along the full length of the blades to prevent air leakage when closed.

The damper frames shall be provided with jamb seals to minimize air leakage. Seals shall be suitable for an operating temperature range of minus 40 degrees F to 200 degrees F.

The leakage rate of each damper when full-closed shall be no more than 3 cfm per sq. foot of damper face area at 1.0 inches water gage static pressure.

2.3.2 Control Valves

2.3.2.1 Valve Assembly

Valve bodies shall be designed for 125 psig minimum working pressure or 150 percent of the operating pressure, whichever is greater. Valve stems shall be Type 316 stainless steel. Valve leakage ratings shall be 0.01 percent of rated Cv value. Class 125 copper alloy valve bodies and Class 150 steel or stainless steel valves shall meet the requirements of ASME B16.5. Cast iron valve components shall meet the requirements of ASTM A126 Class B or C.

2.3.2.2 Butterfly Valves

Butterfly valves shall be the threaded lug type suitable for dead-end service and for modulation to the fully-closed position, with stainless steel shafts supported by bearings, non-corrosive discs geometrically interlocked with or bolted to the shaft (no pins), and EPDM seats suitable for temperatures from minus 20 degrees F to plus 250 degrees F. Valves shall have a means of manual operation independent of the actuator.

2.3.2.3 Two-Way Valves

Two-way modulating valves shall have an equal percentage characteristic.

2.3.2.4 Three-Way Valves

Three-way valves shall have an equal percentage characteristic.

2.3.2.5 Valves for Chilled Water, Condenser Water, and Glycol Fluid Service

- a. Bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for 2 inch valves shall have threaded connections. Bodies for valves from 2-1/2 to 3 inches shall have flanged connections.
- b. Internal valve trim shall be brass or bronze, except that valve stems shall be stainless steel.
- c. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.

- d. Valves 4 inches and larger shall be butterfly valves, unless indicated otherwise.

2.3.2.6 Valves for Hot Water Service

Valves for hot water service below 250 Degrees F:

- a. Bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies for 2 inch valves shall have threaded connections. Bodies for valves from 2-1/2 to 3 inches shall have flanged connections.
- b. Internal trim (including seats, seat rings, modulation plugs, valve stems, and springs) of valves controlling water above 210 degrees F shall be Type 316 stainless steel.
- c. Internal trim for valves controlling water 210 degrees F or less shall be brass or bronze. Valve stems shall be Type 316 stainless steel.
- d. Non-metallic parts of hot water control valves shall be suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher.
- e. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.
- f. Valves 4 inches and larger shall be butterfly valves, unless indicated otherwise.

2.3.2.7 Valves for High Temperature Hot Water Service

Valves for hot water service 250 Degrees F above:

- a. Valve bodies shall conform to ASME B16.34 Class 300. Valve and actuator combination shall be normally closed. Bodies shall be carbon steel, globe type with welded ends on valves 1 inch and larger. Valves smaller than 1 inch shall have socket-weld ends. Packing shall be virgin polytetrafluoroethylene (PTFE).
- b. Internal valve trim shall be Type 316 stainless steel.
- c. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.

2.3.3 Actuators

Provide direct-drive electric actuators for all control applications, except where indicated otherwise. All actuators shall include a feedback loop for detecting actuator faults. The actuator shall report actual position back to the control system. Binary actuators shall provide open/closed status, at a minimum. Modulating actuators and process shall provide position feedback expressed (directly or through span conversion) as percent open/closed. Actuator status shall be derived from actuator position; however, effect may be used in cases where direct feedback is not practical such as VAV coils and dampers.

Use airflow sensors as a feedback loop for damper actuators. Use differential temperature as a feedback mechanism for VAV coil valve actuation.

2.3.3.1 Electric Actuators

Each actuator shall deliver the torque required for continuous uniform motion and shall have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators shall 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. Provide two-position actuators of single direction, spring return, or reversing type. Provide modulating actuators capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators shall 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. Thermal type actuators may only be used on terminal fan coil units, terminal VAV units, convectors, and unit heaters. Spring return actuators shall be provided on all control dampers and all control valves except terminal fan coil units, terminal VAV units, convectors, and unit heaters; unless indicated otherwise. Each actuator shall have distinct markings indicating the full-open and full-closed position, and the points in-between. **Actuators mounted outdoors shall be outdoor rated so that they do not require a weatherproof enclosure.**

2.3.4 Output Signal Conversion

2.3.4.1 Electronic-to-Pneumatic Transducers

Electronic to pneumatic transducers shall convert a 4 to 20 mA or 0 to 10 VDC digital controller output signal to a proportional 0 to 20 psig pressure signal (operator scaleable). Accuracy and linearity shall be 1.0 percent or better. Transducers shall have feedback circuit that converts the pneumatic signal to a proportional 4 to 20 mA or 0 to 10 VDC signal.

2.3.5 Output Switches

2.3.5.1 Control Relays

Field installed and DDC panel relays shall be double pole, double throw, UL listed, with contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light shall be lit when the coil is energized and off when coil is not energized. Relays shall be the socket type, plug into a fixed base, and replaceable without tools or removing wiring. Encapsulated "PAM" type relays may be used for terminal control applications.

2.4 ELECTRICAL POWER AND CONTROL WIRING

2.4.1 Transformers

Transformers shall conform to **UL 506**. For control power other than terminal level equipment, provide a fuse or circuit breaker on the secondary side of each transformer.

2.4.2 Surge and Transient Protection

Provide each control cabinet with surge and transient power protection. Surge protection is not required for small terminal unit controllers such as VAV controllers. Surge and transient protection shall consist of the following devices, installed externally to the controllers.

2.4.2.1 Power Line Surge Protection

Provide surge suppressors on the incoming power at each direct digital controller or grouped terminal controllers and shall be installed externally to the device or devices being protected. Surge suppressors shall be rated in accordance with UL 1449, have a fault indicating light, and conform to the following:

- a. The device shall be a transient voltage surge suppressor, hard-wire type individual equipment protector for 120 VAC/1 phase/2 wire plus ground.
- b. The device shall react within 5 nanoseconds and automatically reset.
- c. The voltage protection threshold, line to neutral, shall be no more than 211 volts.
- d. The device shall have an independent secondary stage equal to or greater than the primary stage joule rating.
- e. The primary suppression system components shall be pure silicon avalanche diodes.
- f. The secondary suppression system components shall be silicon avalanche diodes or metal oxide varistors.
- g. The device shall have an indication light to indicate the protection components are functioning.
- h. All system functions of the transient suppression system shall be individually fused and not short circuit the AC power line at any time.
- i. The device shall have an EMI/RFI noise filter with a minimum attenuation of 13 dB at 10 kHz to 300 MHz.
- j. The device shall comply with IEEE C62.41.1 and IEEE C62.41.2, Class "B" requirements and be tested according to IEEE C62.45.
- k. The device shall be capable of operating between minus 20 degrees F and plus 122 degrees F.

2.4.2.2 MS/TP Communication Line Surge Protection

Provide surge and transient protection for DDC controllers and DDC network related devices connected to phone lines, network communication lines, lines from exterior equipment, and lines from other buildings including mechanical buildings in accordance with the following:

- a. The device shall provide continuous, non-interrupting protection.
- b. The protection shall react within 5 nanoseconds using only solid-state silicon avalanche technology.

- c. The device shall be installed at the distance recommended by its manufacturer.
- d. Include the location of the surge protection devices on the control drawing network riser.

2.4.3 Wiring

Provide complete electrical wiring for the DDC System, including wiring to transformer primaries. Run all control wiring in rigid or flexible conduit, metallic tubing, or covered metal raceways, unless noted otherwise. Control circuit wiring shall not run in the same conduit as power wiring over 100 volts. Circuits operating at more than 100 volts shall be in accordance with Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM. Run all circuits over 100 volts in conduit, metallic tubing, covered metal raceways, or armored cable. Follow cable manufacturer's recommendations or requirements based on the cable usage, such as outdoors and/or underground.

2.4.3.1 Power Wiring

The following requirements are for field-installed wiring:

- a. Wiring for 24 V circuits shall be insulated copper 18 AWG minimum and rated for 300 VAC service.
- b. Wiring for 120 V circuits shall be insulated copper 12 AWG minimum and rated for 600 VAC service.

2.4.3.2 Analog Signal Wiring and Binary Wiring

Provide in accordance with control manufacturer's recommendations and the following: Field-installed analog signal wiring shall be 18 AWG single or multiple twisted pair. Each cable shall be 100 percent shielded and have a 20 AWG drain wire. Each wire shall have insulation rated for 300 VAC service. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape. All binary input and output wiring shall be 18 AWG.

2.4.3.3 MS/TP Communication Bus

- a. Provide system manufacturer's recommended or preferred cabling.
- b. Follow cable manufacturer's recommendations or requirements based on the cable usage, such as outdoors and/or underground.
- c. Splices in communication cable are not allowed. Segments of communication cable between field devices shall be solid lengths with no splices.

2.4.3.4 Conduit

Conduit for controls less than 100 volts shall be colored blue. Junction box cover plates, cable/wire trough covers, etc., for controls shall be blue. Fittings and boxes do not need to be blue.

2.5 FIRE PROTECTION DEVICES

2.5.1 Duct Smoke Detectors

Provide duct smoke detectors in HVAC ducts in accordance with NFPA 72 and NFPA 90A, except as indicated otherwise. Provide UL listed or FM approved detectors, designed specifically for duct installation.

Furnish detectors under Section 28 31 76 INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE and install under this section. Connect new detectors to the building fire alarm panel.

2.6 INDICATORS

2.6.1 Pressure Gauges for Pneumatic Controls

Provide a pressure gauge at each pneumatic control input and output. Gauges shall have a 2-inch diameter face and a 0 to 30 psi scale with 1 psi graduations.

2.7 VARIABLE FREQUENCY (MOTOR) DRIVES

Provide variable frequency drives (VFDs) as indicated. VFDs shall convert 208 or 480 volt (plus or minus 10 percent), three phase, 60 hertz (plus or minus 2Hz), utility grade power to adjustable voltage/frequency, three phase, AC power for stepless motor control from 5 percent to 200 percent of base speed. VFDs shall be UL listed as delivered to the end user. The VFD shall meet the requirements specified in the most current National Electrical Code. Each VFD shall also meet the following:

- a. The VFD shall use sine coded Pulse Width Modulation (PWM) technology. PWM calculations shall be performed by the VFD microprocessor.
- b. The VFD shall be capable of automatic control by a remote 4-20 mA signal, by network command, or manually by the VFD control panel.

2.7.1 VFD Quality Assurance

VFDs shall be the manufacturer's current standard production unit with at least 10 identical units successfully operating in the field.

2.7.2 VFD Service Support

- a. **Warranty:** Provide the VFDs with a minimum 24-month full parts and labor warranty. The warranty shall start when the contract's HVAC system is accepted by the Government. Include warranty documentation, dates, and contact information with the VFD on-site service manuals.
- b. **VFD Service Manuals:** Provide the VFDs with all necessary installation, operation, maintenance, troubleshooting, service, and repair manuals in English including related factory technical bulletins. Provide the documents factory bound, in sturdy 3-ring binders, or hard bound covers. Provide a title sheet on the outside of each binder indicating the project title, project location, installing contractor, contract number, and the VFD manufacturer,

address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. The documentation provided shall be specifically applicable to this project, shall be annotated to reflect the actual project conditions, and shall provide a complete and concise depiction of the installed work. Provide a storage cabinet on or near the VFD large enough to hold all of the documentation. Have the cabinet's proposed installation site approved in advance by the Contracting Officer. Prominently label the cabinet "VFD OPERATION AND MAINTENANCE MANUALS." Clearly label each manual with the wording "MECHANICAL ROOM COPY - DO NOT REMOVE".

- c. Technical Support: Provide the VFDs with manufacturer's technical telephone support in English, readily available during normal working hours, and free of charge for the life of the equipment.
- d. Initial Start-Up: Provide the VFDs with factory-trained personnel for the on-site start-up of the HVAC equipment and associated VFD. The personnel shall be competent in the complete start-up, operation, and repair of the particular model VFD installed. The factory start-up representative shall perform the factory's complete recommended start-up procedures and check-out tests on the VFD. Include a copy of the start-up test documentation with the VFD on-site service manuals.
- e. Provide the VFDs with on-site/hands-on training for the user and maintenance personnel. Provide a capable and qualified instructor with minimum two years field experience with the operation and maintenance of similar VFDs. The training shall occur during normal working hours and last not less than 2 hours. Coordinate the training time with the Contracting Officer and the end user. The VFD service manuals shall be used during the training. The contractor shall ensure the manuals are on-site before the start of training. The training shall cover all operational aspects of the VFD.

2.7.3 VFD Features

VFDs shall have the following features:

- a. A local operator control keypad capable of:
 - (1) Remote/Local operator selection with password access.
 - (2) Run/Stop and manual speed commands.
 - (3) All programming functions.
 - (4) Scrolling through all display functions.
- b. Digital display capable of indicating:
 - (1) VFD status.
 - (2) Frequency.
 - (3) Motor RPM.
 - (4) Phase current.
 - (5) Fault diagnostics in descriptive text.

(6) All programmed parameters.

(7) Load power.

- c. Standard PI loop controller with input terminal for controlled variable and parameter settings.
- d. User interface terminals for remote control of VFD speed, speed feedback, and an isolated form C SPDT relay, which energizes on a drive fault condition.
- e. An isolated form C SPDT auxiliary relay which energizes on a run command.
- f. A metal NEMA 1 enclosure for indoors, NEMA 4 with heater for outdoors.
- g. An adjustable carrier frequency with 16 KHz minimum upper limit.
- h. A built in DC buss reactor with 3 percent minimum impedance to protect the VFDs DC buss capacitors and rectifier section diodes.

i. HOA/Bypass Switches

2.7.4 Programmable Parameters

VFDs shall include the following operator programmable parameters:

- a. Upper and lower limit frequency.
- b. Acceleration and Deceleration rate.
- c. Variable torque volts per Hertz curve.
- d. Starting voltage level.
- e. Starting frequency level.
- f. Display speed scaling.
- g. Enable/disable auto-restart feature.
- h. Enable/disable soft stall feature.
- i. Motor overload level.
- j. Motor stall level.
- k. Jump frequency and hysteresis band.
- l. PWM carrier frequency.

2.7.5 Protective Features

VFDs shall have the following protective features:

- a. An electronic adjustable inverse time current limit with consideration for additional heating of the motor at frequencies below 45Hz, for the protection of the motor.

- b. An electronic adjustable soft stall feature, allowing the VFD to lower the frequency to a point where the motor will not exceed the full-load amperage when an overload condition exists at the requested frequency. The VFD will automatically return to the requested frequency when load conditions permit.
- c. A separate electronic stall at 110 percent VFD rated current, and a separate hardware trip at 190 percent current.
- d. Ground fault protection that protects the output cables and motor from grounds during both starting and continuous running conditions.
- e. The ability to restart after the following faults:
 - (1) Overcurrent (drive or motor).
 - (2) Power outage.
 - (3) Phase loss.
 - (4) Over voltage/Under voltage.
- f. The ability shut down if inadvertently started into a rotating load without damaging the VFD or the motor.
- g. The ability to keep a log of a minimum of four previous fault conditions, indicating the fault type and time of occurrence in descriptive text.
- h. The ability to sustain 110 percent rated current for 60 seconds
- i. The ability to shutdown safely or protect against and record the following fault conditions:
 - (1) Over current (and an indication if the over current was during acceleration, deceleration, or running).
 - (2) Over current internal to the drive.
 - (3) Motor overload at start-up.
 - (4) Over voltage from utility power.
 - (5) Motor running overload.
 - (6) Over voltage during deceleration.
 - (7) VFD over heat.
 - (8) Load end ground fault.
 - (9) Abnormal parameters or data in VFD EEPROM.

2.7.6 Minimum Operating Conditions

VFDs shall be designed and constructed to operate within the following service conditions:

- a. Ambient Temperature Range, 0 to 120 degrees F.
- b. Non-condensing relative humidity to 90 percent.

2.7.7 Additional Features

Provide VFDs with the following additional features:

- a. BACnet communication interface port

PART 3 EXECUTION

3.1 INSTALLATION

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems. All material and equipment shall be installed in accordance with the manufacturer's recommendations for the intended purpose. Maintain a copy of the manufacturer's recommendations on the Construction Site. Use the more stringent methods when manufacturer's recommendations, and plans & specification requirements differ. Use the "Preferred" method when alternative methods are given. The word "should" will be considered to mean "shall". Bring any conflicts between manufacturer's recommendations and plans & specification requirements to the Government's attention. All equipment shall be installed level and plumb.

3.1.1 Pre-Installation Meeting

Prior to starting the installation, meet with the Contracting Officer's Technical Representative (COTR) and the BAS owner to develop a mutual understanding relative to the details of the DDC system requirements. Requirements to be discussed include, but not limited to, required submittals, work schedule, field quality control, BAS Supervisory controller configuration requirements, and project DDC Specification requirements.

3.1.2 Demolition

Remove and/or demolish all existing controls, cabling, conductors, conduit, controllers, power circuits and cabinets that are no longer needed after new work is installed. Contractor shall inform government prior to start of demolition and shall give the government the option to salvage any existing equipment. Contractor shall remove all unused existing conduit and shall not reuse any existing conduit. Any existing systems to remain, must remain functional and operate properly after all demolition is complete.

3.1.3 BACnet Naming and Addressing

Coordinate with the EMCS Owner and provide unique naming and addressing consistent with existing buildings already loaded on the EMCS server. All DDC controllers shall have a Camp Lejeune unique instance number and all Supervisory Building Controllers shall have a Camp Lejeune unique name. Names are managed by the Government.

- a. MAC Address

Every BACnet device shall have an assigned and documented MAC Address unique to its network. For Ethernet networks, document the MAC

Address assigned at its creation. For MS/TP networks, assign addresses from 0-127. Do not use the controls manufacturer reserved addresses for field controllers. This is typically 0-3. Also the BACnet Instance ID for MAC Address 127, Trunk 1, is reserved for the Supervisory controller. Supervisory Controller Global ID and instance numbers are to be obtained from Camp Lejeune Public Works Operations to ensure duplicates do not occur. Point of Contact:

Public Works Division/EMCS
1005 Michael Road / Building 1005
MCB Camp Lejeune, NC 28547
(910) 450-7846

For MS/TP, assign from 01 to 127 unless reserved by the manufacturer.

b. Network Numbering

Assign unique numbers to each new network installed on the BACnet internetwork. Provide ability for changing the network number; either by device switches, network computer, or field operator interface. The BACnet internetwork (all possible connected networks) can contain up to 65,534 possible unique networks.

c. Device Object Identifier Property Number

Assign unique Device "Object_Identifier" property numbers or device instances for each device on the BACnet internetwork. Provide for future modification of the device instance number; either by device switches, network computer, or field interface. Instance numbers must be field assignable. BACnet allows up to 4,194,302 possible unique devices per internetwork.

d. Device Object Name Property Text

Each object on the Camp Lejeune EMCS has a unique point name, which is made up of the object or short name stored in the controller and the equipment identifier, which is stored in the supervisory building controller (SBC). The long point name combines this object name with the name stored in the SBC that describes the controller or location of the object. The device object name property field shall support 32 minimum printable characters. The point name follows the general convention:

Building.Equipment.Object Name

Example: HP512.AHU-3.DA-T. See Attachments one through three for equipment names, object names, object groupings, and area names.

e. Object Name Property Text (Other than Device Objects)

The object name identifies the specific point. Only object names on the approved Camp Lejeune list shall be used. From the example above, the point name is: "DA-T". See Attachment for the approved Camp Lejeune list. If object name is not in the approved list, then contractor shall send a Request For Information (RFI) to their COTR. The object name property field shall support 32 minimum printable characters.

f. Object Description

The controller shall also store an alpha numeric description of the object name. The controller shall support a minimum of 30 printable characters. From the example above the object description is: "Discharge Air Temperature". Both short names and long names shall be populated in the database.

g. List of Attachments

Attachment 1 - NOT USED
Attachment 2 - Object Names
Attachment 3 - NOT USED
Attachment 4 - Niagara BAS Alarms Policy
Attachment 5 - Trend (History)

3.1.4 Minimum BACnet Object Requirements

a. Use of Standard BACnet Objects in accordance with existing Camp Lejeune Standards

For the following points and parameters, use standard BACnet objects, where all relevant object properties can be read using BACnet's Read Property Service, and all relevant object properties can be modified using BACnet's Write Property Service:
all device physical inputs and outputs, all set points, all PID tuning parameters, all calculated pressures, flow rates, and consumption values, all alarms, all trends, all schedules, and all equipment and lighting circuit operating status.

b. BACnet Object Description Property

The Object Description property shall support 32 minimum printable characters. For each object, complete the description property field using a brief, narrative, plain English description specific to the object and project application. For example: "HW Pump 1 Proof." Document compliance, length restrictions, and whether the description is writeable in the device PICS.

c. Analog Input, Output, and Value Objects

Support and provide Description and Device_Type text strings matching signal type and engineering units shown on the points list.

d. Binary Input, Output, and Value Objects

Support and provide Inactive_Text and Active_Text property descriptions matching conditions shown on the points list.

e. Calendar Object

For devices with scheduling capability, provide at least one Calendar Object with ten-entry capacity that incorporates Federal Holidays. All operators may view Calendar Objects; authorized operators may make modifications from a workstation. Enable the writeable Date List property and support all calendar entry data types.

f. Schedule Object

Use Schedule Objects for all building system scheduling. All operators may view schedule entries; authorized operators may modify schedules from a workstation.

g. Loop Object or Equal

Use Loop Objects or equivalent BACnet objects in each applicable field device for PID control. Regardless of program method or object used, allow authorized operators to adjust the Update Interval, Setpoint, Proportional Constant, Integral Constant, and Derivative Constant using BACnet read/write services.

h. Setpoints

All setpoints must be BACnet exposed for auto discovery purposes if needed.

3.1.5 Minimum BACnet Service Requirements

a. Command Priorities

Use commandable BACnet objects to control machinery and systems, providing the priority levels listed below. If the sequence of operation requires a different priority, obtain approval from the Contracting Officer.

<u>Priority Level</u>	<u>Application</u>
1	Manual-Life Safety
2	Automatic-Life Safety
3	(User Defined)
4	(User Defined)
5	Critical Equipment Control
6	Minimum On/Off
7	(User Defined)
8	Manual Operator
9	(User Defined)
10	(User Defined)
11	Load Shedding
12	(User Defined)
13	(User Defined)
14	(User Defined)
15	(User Defined)

<u>Priority Level</u>	<u>Application</u>
16	(User Defined)

b. Alarming

- (1) Alarm Priorities - Coordinate alarm and event notification with the BAS Owner.
- (2) Notification Class - Enable writeable Priority, Ack Required, and Recipient List properties of Notification Class objects.
- (3) Event Notification Message Texts - Use condition specific narrative text and numerical references for alarm and event notification.

c. Updating Displayed Property Values

Allow workstations to display property values at discrete polled intervals, or based on receipt of confirmed and unconfirmed Change of Value notifications. The COV increment shall be adjustable by an operator using BACnet services, and polled intervals shall be adjustable at the operator workstation.

3.1.6 Local Area Networks

Obtain Government approval before connecting new networks with existing networks. Network numbers and device instance numbers shall remain unique when joining networks. Do not change existing network addressing without Government approval. See also "BACnet Naming and Addressing".

3.1.7 BACnet Routers and Protocol Gateways

Provide the quantity of BACnet routers necessary for communications shown on the BACnet Communication Architecture schematic. Provide BACnet routers with BACnet Broadcast Message Device (BBMD) capability on each BACnet internetwork communicating across an IP network. Configure BBMD tables to enable unicast forwarding of broadcast messaging across Layer-3 IP subnets.

3.1.8 Plant Controllers

Equipment such as VFD's, chillers, and boilers shall have hardwired enable(start/stop), and status points from the plant controller, VFD's shall also have a hardwired speed command. Additionally, this equipment shall have a BACnet interface for monitoring.

3.1.9 Wiring Criteria

- a. Run circuits operating at more than 100 volts in rigid or flexible conduit, metallic tubing, covered metal raceways, or armored cable.
- b. Run all control wiring in blue rigid or flexible conduit, blue

metallic tubing, or covered metal raceways, unless noted otherwise. All control wiring located inside mechanical rooms shall be in conduit or metallic tubing. All conduit and junction box covers, cable/wire trough covers, etc., shall be blue in color."

- c. Do not run binary control circuit wiring in the same conduit as power wiring over 100 volts. Where analog signal wiring requires conduit, do not run in the same conduit with AC power circuits or control circuits operating at more than 100 volts.
- d. Provide circuit and wiring protection required by NFPA 70.
- e. Minimum conduit size is 3/4-inch. Maximum conduit fill is 40% or the cable manufacturer's recommended amount whichever is less. Provide plastic end sleeves at all conduit terminations to protect wiring from burrs.
- f. Do not bury aluminum-sheathed cable or aluminum conduit in concrete.
- g. Input/output identification: Permanently label each field-installed wire, cable, and pneumatic tube at each end with descriptive text using a commercial wire marking system, minimum 9 point font. Labels shall fully encircle the wire, cable, or tube. The single line text shall run parallel to the wire, cable, or tube and shall be repeated so as to be viewable without twirling or twisting the wire. Locate the markers within 2 inches of each termination. Label shall include type of network and destination of cable (ex. BACnet/AHU-1). Match the names and I/O number to the project's point list. Similarly label all power wiring serving control devices, including the word "power" and panel board and circuit number, or transformer location in the label. Number each pneumatic tube every six feet. Label all terminal blocks with alpha/numeric labels. All wiring and the methods shall be in accordance with UL 508A.
- h. Permanently display controller wiring diagram for each controller on the inside of the control cabinet door. Diagram shall be neatly lettered and taped or adhered with sticky back label.
- i. Conduit identification: All conduits shall be labeled within 36 inches from terminations, boxes, bends or wall penetrations. Labels shall be 3/8 inches bold black lettering on white background and indicate what system the conduit contains. Apply labels every 10 feet of line of sight or a distance agreed upon by Camp Lejeune Public Works Department. Provide label for each side of a wall penetration by the conduit. The agreed upon distance shall be for a single building or project only. Label shall be visible and legible, while standing on the floor, from up to three sides with a minimum dimension of 1.9 inches x 4 inches. Conduit that includes power circuits shall be labeled with source panel and circuit, and destination cabinet or equipment. When MSTP is installed within conduit, label conduit with trunk number and to and from device (ie. MSTP-01 From VAV 1-1 to VAV 1-2).

Provide a label at each control panel on the 120 VAC conduit. The label shall contain the source panel and circuit identifier.

Label Example: SF-C, SF-S, SF-O (3 cables, Supply Fan Command, Supply Fan Status, Supply Fan Output).

Label Example: ZN-T/ZN-H/ZN-Q (1 cable, Zone Temperature, Zone Humidity, Zone Quality).

- j. Each terminal device shall have its own terminal conduit run. Device boxes or devices or panels shall not be used as "pass thru" for wiring.
- k. Conduit to equipment and devices shall be run tight to walls, and ceilings. Avoid conduit on the floor, i.e. conduit shall not block access to or past equipment. Flex conduit is to be used only when EMT or rigid conduit is not able to satisfy the application such as a transition to a sensor or equipment. Flex conduit shall be limited to a maximum length of 3 ft.
- l. For controller power, provide new 120 VAC circuits, with ground if not defined on the electrical drawings. Provide each circuit with a dedicated breaker, and run wiring in its own conduit, separate from any control wiring. Connect the controller's ground wire to the electrical panel ground; conduit grounds are not acceptable. Include a label on the 120 VAC circuit conduit at each control panel. The label is to include the source panel and circuit identification. The label size shall be a minimum of 1.9 inches by 4 inches, 3/8 inch black lettering on white background.
- m. Supervisory Building Controllers (SBC) shall be powered from a dedicated transformer for the SBC only. Each control cabinet shall have a dedicated 24 volt transformer. The 120 VAC power branch circuit shall be dedicated to the DDC control system. Factory provided transformers in equipment must be used as a source of power only for the control devices intended by the equipment manufacturer.
- n. Surge Protection: Install surge protection according to manufacturer's instructions. Multiple controllers fed from a common power supply may be protected by a common surge protector, properly sized for the total connected devices.
- o. All terminations in panels shall be made at a terminal block if not connected directly to a panel device, ie Field Controller, Supervisory Controller, relays, transmitters, etc. No wire nuts are allowed in panels, VAV boxes, control panels, relay panels or any other type of enclosure shall follow this requirement. High and low voltage wires must not land on the same terminal block unless they are separated and of a different color and/or clearly identified.
- p. Grounding: Ground controllers and cabinets to a good earth ground as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Conduit grounding is not acceptable; all grounding shall have a direct path to the building earth ground. Ground sensor drain wire shields at the controller end.
- q. The Contractor shall be responsible for correcting all associated MS/TP and SA bus wiring, auxiliary bus wiring, termination, end of line, and ground loop problems.
- r. Run wiring in panel enclosures in covered wire track.
- s. Control cabinets, wiring boxes, cable/wiring troughs, panel enclosures, etc., must be clean of all debris, metal shavings, etc.
- t. Low voltage cable must not be supported directly from "all thread"

rod. If cabling/wiring is permitted to be run without conduit/raceway it must be supported using a retaining device such as a bridle ring or J hook, and where appropriate connected to the all thread rod using a standoff device. Openly installed cabling/wiring must be approved by Camp Lejeune Public Works Department.

- u. For serviceability, allow a minimum of 2 inches of exposed wire or cable from any termination point, i.e. between wireway and field controller terminations.
- v. Wireway inside panels and junction boxes shall be maximum 40% filled.

3.1.10 Accessibility

Install all equipment so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install digital controllers, data ports, and concealed actuators, valves, dampers, air flow stations and like equipment in locations freely accessible through access doors. Install power surge protection such that it is replaceable without removing other components.

3.1.11 Digital Controllers

- a. Install as stand alone control devices (see definitions).
- b. Locate control cabinets at the locations shown on the drawings. If not shown on the drawings, install in the most accessible space, close to the controlled equipment. Controllers must be installed in a manufacturer's required/recommended enclosure for each type of controller.
- c. Provide a dedicated analog output to each output device, such as variable frequency driven pump motors in an alternating arrangement.
- d. Equipment such as VFD's must have hardwired enable(start/stop), speed command and status points from the controller. Software points are not allowable. Additionally, this equipment shall have a BACnet interface for monitoring

3.1.12 Hand-Off-Auto Switches

Wire safety controls such as smoke detectors, freeze protection thermostats, and emergency shut down switches to protect the equipment during both hand and auto operation.

3.1.13 Emergency Shut Down Switches (ATFP)

Quantity and location as shown on the drawings. Switches must be hardwired such that all fans and dampers that circulate air between rooms, or between inside and outside must shut down/close regardless of equipment HOA switch position and without the use of software. ATFP circuit must be energized to allow equipment to operate; i.e. activation of the emergency shut down switch will de-energize the circuit and open relays at the equipment. Additionally, activation of the switch must signal the DDC system to shut all air moving equipment off/closed and initiate an alarm. Reset of the DDC system must be manual.

3.1.13.1 Safety and Shutdown Circuit Monitoring

All safety or shutdown circuits, or any circuit that can disable a system, shall be monitored by the DDC system as separate inputs for each circuit. This shall include, but is not limited to, Low Temperature Limit, Duct Mounted Smoke Detector, Discharge Air High Pressure Limit, Boiler Emergency Pushbutton, Carbon Monoxide, Gas Detection, ATFP, etc. Supervisory controller alarm reporting shall be configured for each individual circuit alarm.

3.1.14 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 sensors according to manufacturer's instructions. Do not use sensors designed for one application in a different application.

3.1.14.1 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. Mount the center of the sensor 54 inches above the floor to meet ADA requirements.

3.1.14.2 Duct Temperature Sensors

- a. Probe Type: Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. Seal the duct insulation penetration vapor tight.
- b. Averaging Type (and coil freeze protection thermostats): Weave the capillary tube sensing element in a serpentine fashion perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports. Prevent contact between the capillary and the duct or air handler internals. Provide a duct access door at the sensor location. The access door shall be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors shall be fully accessible through the air handler's access doors without removing any of the air handler's internals.

3.1.14.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. 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 shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide thermal conductivity material within the well to fully coat the inserted sensor.

3.1.14.4 Outside Air Temperature & Humidity Sensors

Provide outside air temperature and humidity sensors in weatherproof enclosures on the north side of the building, away from exhaust hoods and other areas that may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.15 Energy Meters

Provide and locate energy meters as indicated. Connect each meter output to the DDC system, to measure both instantaneous and accumulated energy usage.

3.1.16 Damper Actuators

Where possible, mount actuators outside the air stream in accessible areas.

3.1.17 Pressure Sensors

Locate pressure sensors as indicated.

3.1.18 Pneumatic Tubing

Run tubing concealed in finished and unfinished areas. Run tubing in conduit, such as EMT. For tubing enclosed in concrete, provide rigid metal conduit. Run tubing parallel and perpendicular to building walls. Use 5 foot maximum spacing between tubing supports. Polyethylene tubing over 2 feet long must be run in conduit such as EMT. Caulking joints is not permitted. Do not run tubing and electrical power conductors, or Class 1, 2 or 3 cables, in the same conduit. All tubing must be terminated with an appropriate fitting designed for that purpose.

3.1.19 Component Identification Labeling

Using an electronic hand-held label maker with white tape and bold black block lettering, provide an identification label on the exterior of each new control panel, control device, actuator, and sensor. Also provide labels on the exterior of each new control actuator indicating the (full) open and (full) closed positions. For labels located outdoors, use exterior grade label tape, and provide labels on both the inside and outside of the panel door or device cover. Acceptable alternatives are white plastic labels with engraved bold black block lettering permanently attached to the control panel, control device, actuator, and sensor. Have the labels and wording approved by the BAS Owner prior to installation. Devices with field adjustable setpoints, such as Air Filter Status, Duct Pressure Safety Limit, etc., must have the field adjusted setpoint and date included on the label. Components mounted above a ceiling or service hatch must also have the component identification visible from below. Examples: "A VAV controller, exhaust fan relay, Differential Pressure Transmitter, etc., identification would be included on the ceiling grid, or service hatch, in the area of the controller or field device." Supervisory Controller: Provide a removable label (not permanent marker) with the Global ID(s), IP Address and all login credentials. Niagara JACE should include login credentials for both the Station and Platform.

3.1.20 Network Communication Lines

Network connections by the Government are required for each new supervisory controller back to the telecom room. Provide the Contracting Officer at least 120 days advance notice of need. Provide one inch conduit and two (2) green Cat 6 cables from the point of connection of the BAS to the point of connection to the MCEN (most likely in the telephone equipment room). The conduit for these runs MCEN homeruns shall be the only controls conduit that is not blue in color. For each run, provide an

additional 20 feet of extra cable, coiled up in the telecom closet. Cables must be terminated and tested.

3.2 TEST AND BALANCE SUPPORT

The controls contractor shall coordinate with and provide on-site support to the test and balance (TAB) personnel specified under Section 23 05 93 TESTING, ADJUSTING AND BALANCING. This support shall include:

- a. On-site operation and manipulation of control systems during the testing and balancing.
- b. Control setpoint adjustments for balancing all relevant mechanical systems, including VAV boxes.
- c. Tuning control loops with setpoints and adjustments determined by TAB personnel.

3.3 INTERFACE WITH EXISTING EMCS

Provide 16 hours of assistance to the Government with interfacing the BAS to the Base wide EMCS. The Government will make the final connection of the BAS to the MCEN. This 16 hours does not include completion or corrections to the installed BAS as defined in the contract documents. This 16 hours is for assisting the interface and for making revisions to the BAS that may be needed outside of the contract requirements. Approved As-Build control drawings must be available for the EMCS operator performing the interfacing. Graphics shall be created prior to interface with existing EMCS.

3.4 CONTROLS SYSTEM OPERATORS MANUALS

Provide four electronic and printed copies of a Controls System Operators Manual. The manual shall be specific to the project, written to actual project conditions, and provide a complete and concise depiction of the installed work. Provide information in detail to clearly explain all operation requirements for the control system.

Provide with each manual: CDs of the project's control system drawings, control programs, data bases, graphics, and all items listed below. Include gateway back-up data and configuration tools where applicable. Provide CDs in jewel case with printed and dated project-specific labels on both the CD and the case. For text and drawings, use Adobe Acrobat or MS Office file types. When approved by the Government, AutoCAD and Visio files are allowed. Give files descriptive English names and organize in folders.

Provide printed manuals in sturdy 3-ring binders with a title sheet on the outside of each binder indicating the project title, project location, contract number, and the controls contractor name, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. Manuals shall include the following:

- a. A copy of the as-built control system (shop) drawings set, with all items specified under the paragraph SUBMITTALS. Indicate all field changes and modifications. As-Built Control Drawings shall be marked "As-Built" on the cover page and in the title block of each page. Revisions must be dated, may be hand or CAD annotated.

- b. A copy of the project's mechanical design drawings, including any official modifications and revisions.
- c. A copy of the project's approved Product Data submittals provided under the paragraph SUBMITTALS.
- d. A copy of the project's approved Performance Verification Testing Plan and Report.
- e. A copy of the project's approved final TAB Report.
- f. Printouts of all control system programs, including controller setup pages if used. Include plain-English narratives of application programs, flowcharts, and source code.
- g. Printouts of all physical input and output object properties, including tuning values, alarm limits, calibration factors, and set points.
- h. A table entitled "AC Power Table" listing the electrical power source for each controller. Include the building electrical panel number, panel location, and circuit breaker number.
- i. The DDC manufacturer's hardware and software manuals in both print and CD format with printed project-specific labels. Include installation and technical manuals for all controller hardware, operator manuals for all controllers, programming manuals for all controllers, operator manuals for all workstation software, installation and technical manuals for the workstation and notebook, and programming manuals for the workstation and notebook software.
- j. A list of qualified control system service organizations for the work provided under this contract. Include their addresses and telephone numbers.
- k. A written statement entitled "Technical Support" stating the control system manufacturer or authorized representative will provide toll-free telephone technical support at no additional cost to the Government for a minimum of two years from project acceptance, will be furnished by experienced service technicians, and will be available during normal weekday working hours. Include the toll-free technical support telephone number.
- l. A written statement entitled "Software Upgrades" stating software and firmware patches and updates will be provided upon request at no additional cost to the Government for a minimum of two years from project acceptance. Include a table of all DDC system software and firmware provided under this contract, listing the original release dates, version numbers, part numbers, and serial numbers.
- m. Submit any and all updated field controller files, and BACnet Building Controller data base during the acceptance and warranty information and warranty periods or as a result of a latent defect.

3.4.1 Storage Cabinets

In one project mechanical room, typically near the BACnet Building

Controller provide a wall-mounted storage cabinet with hinged doors. In addition to the number of manuals specified above, provide an additional copy of the manuals in this mechanical room storage cabinet. Provide cabinets large enough to hold the entire set of Controls System Operators Manuals, and the HVAC operation and maintenance manuals provided under Division 23 Heating, Ventilating, and Air Conditioning. Locate cabinets adjacent to DDC control panels where applicable. Have each cabinet's proposed installation site approved in advance by the Contracting Officer and the BAS Owner. Prominently label each cabinet with the wording "OPERATION AND MAINTENANCE MANUALS." Prominently label each binder with the wording "MECHANICAL ROOM COPY - DO NOT REMOVE."

3.5 PERFORMANCE VERIFICATION TESTING (PVT)

3.5.1 General

The PVT shall demonstrate compliance of the control system work with the contract requirements. The PVT shall be performed by the Contractor and may be witnessed by the Government. If the project is phased, provide separate testing for each phase. A Pre-PVT meeting to review the Pre-PVT Checklist is required to coordinate all aspects of the PVT and shall include the Contractor's QA representative, the Contractor's PVT administrator, the Contracting Officer's representative, and the BAS Owner.

3.5.2 Sensor Accuracy Checks

Include a one-point accuracy check of each sensor in the PVT procedures.

3.5.3 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.

3.5.4 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 BACnet Trend Log or Trend Log Multiple 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.

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.

3.5.5 Performance Verification Testing Plan

Submit a detailed PVT Plan of the proposed testing for Government approval. Develop the PVT Plan specifically for the control system in this contract. The PVT Plan shall be a clear list of test items arranged in a logical sequence. It shall include each and all sequences of all controllers. Include sequence tested, intended test procedure, required assisted personnel (such as the mechanical contractor), the expected response, and the pass/fail criteria for every component tested. Include pass/fail column for test, and space for comments, signature and date lines for Contractor's PVT administrator and Contractor's QA representative. The PVT plan shall include the prescriptive pre-PVT check list in addition to the Contractor generated controller specific testing sequences. The final part of the PVT Report shall be 72 hour trends. Trends shall demonstrate stable operation of the PID loop controls and ability to maintain all temperatures within +/- 1 degree F of setpoint. Propose criteria for the trends, ie, change of state, change of value with the trigger value, and time intervals in the PVT Plan submission for approval.

3.5.6 PVT Sample Size

Test all controllers unless otherwise directed. Trends will be reported on all central plant equipment and primary air handling unit controllers, and all terminal controllers such as VAV boxes and fan coil units. If controller lacks sufficient capacity to store all trends, then contractor shall provide additional storage or field servers as necessary for the duration of PVT and until all trends are acceptable to the government. Additional trends shall be provided if requested by Camp Lejeune or a commissioning agent.

3.5.7 Pre-Performance Verification Testing Checklist

Submit the following as a part of the PVT Plan and the PVT Report. Each item shall include a column for the Contractor's initial/date. This form may be a general form applicable to all controllers and submitted only once in the PVT Plan. Each controller shall have an individual checklist with controller title and identified in the PVT Report..

- a. Verify all mechanical installation work is successfully completed and started up by the appropriate personnel.
- b. Verify all required control system components, wiring, and accessories are installed.
- c. Verify the installed control system architecture matches approved drawings.
- d. Verify all control circuits operate at the proper voltage and are free from grounds or faults.
- e. Verify all required surge protection is installed.
- f. Verify the A/C Power Table specified in the paragraph CONTROLS SYSTEM OPERATORS MANUALS is accurate.

- g. Verify all DDC network communications function properly, including uploading and downloading programming changes.
- h. Verify each digital controller's programming is backed up.
- i. Verify all wiring, components, and panels are properly labeled.
- j. Verify all required points are programmed into devices.
- k. Verify all valve and actuator zero and span adjustments are set properly. List each device and span for that device. label device with span setting and adjustment date.
- l. Verify all sensor readings are accurate and calibrated. List each sensor, sensor reading, and measured value. Label device with calibrated value and the calibration date.
- m. Verify each control valve and actuator goes to normal position upon loss of power. List each device and normal position.
- n. Verify each controller works properly in stand-alone mode by disconnecting the BACnet bus.

3.5.8 Conducting Performance Verification Testing

- a. Conduct PVT after approval of the PVT Plan. Notify the Contracting Officer of the planned PVT at least 15 days prior to testing. Provide an estimated time table required to perform the testing. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of the PVT. Ensure that testing personnel are regularly employed in the testing and calibration of DDC systems. Using the project's as-built control system (shop) drawings, the project's mechanical design drawings, and the approved PVT Plan, conduct the PVT.

Controls Contractor and Equipment Supplier(s) must share and coordinate PVT testing responsibilities for equipment provided with on-board factory packaged controls such as boiler controllers, dedicated outside air systems (DOAS's), and packaged pumping systems.

- b. During testing, identify any items that do not meet the contract requirements and if time permits, conduct immediate repairs and re-test. Otherwise, deficiencies shall be investigated, corrected, and re-tested later. Document each deficiency and corrective action taken.
- c. If re-testing is required, follow the procedures for the initial PVT. The Government may require re-testing of any control system components affected by the original failed test.

3.5.9 Controller Capability and Labeling

Test the following for each controller:

- a. Memory: Demonstrate that programmed data, parameters, and trend/alarm history collected during normal operation is not lost during power failure.

- b. Direct Connect Interface: Demonstrate the ability to connect directly to each type of digital controller with a portable electronic device like a notebook computer or PDA. Show that maintenance personnel interface tools perform as specified in the manufacturer's technical literature.
- c. Stand Alone Ability: Demonstrate controllers provide stable and reliable stand-alone operation using default values for values normally read over the network.
- d. Wiring and AC Power: Demonstrate the ability to disconnect any controller safely from its power source using the AC Power Table. Demonstrate the ability to match wiring labels easily with the control drawings. Demonstrate the ability to locate a controller's location using the BACnet Communication Architecture Schematic and floor plans.
- e. Nameplates and Tags: Show the nameplates and tags are accurate and permanently attached to control panel doors, devices, sensors, and actuators.

3.5.10 Workstation and Software Operation

For every user workstation or notebook provided:

- a. Show points lists agree with naming conventions.
- b. Show that graphics are complete.
- c. Show the UPS operates as specified.

3.5.11 BACnet Communications and Interoperability Areas

- a. Data Presentation: On each BACnet Operator Workstation, demonstrate graphic display capabilities.
- b. Reading of Any Property: Demonstrate the ability to read and display any used readable object property of any device on the network.
- c. Setpoint and Parameter Modifications: Show the ability to modify all setpoints and tuning parameters in the sequence of control or listed on project schedules. Modifications are made with BACnet messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.
- d. Peer-to-Peer Data Exchange: Show all BACnet devices are installed and configured to perform BACnet read/write services directly (without the need for operator or workstation intervention), to implement the project sequence of operation, and to share global data.
- e. Alarm and Event Management: Show that alarms/events are installed and prioritized according to the BAS Owner. Demonstrate time delays and other logic is set up to avoid nuisance tripping, e.g., no status alarms during unoccupied times or high supply air during cold morning start-up. Show that operators with sufficient privilege can read and write alarm/event parameters for all standard BACnet event types. Show that operators with sufficient privilege can change routing (BACnet notification classes) for each alarm/event including the destination, priority, day of week, time of day, and the type of

transition involved (types of transition include but are not limited to the following: TO-OFF NORMAL and TO-NORMAL).

- f. Schedule Lists: Show that schedules are configured for start/stop, mode change, occupant overrides, and night setback as defined in the sequence of operations.
- g. Schedule Display and Modification: Show the ability to display any schedule with start and stop times for the calendar year. Show that all calendar entries and schedules are modifiable from any connected workstation by an operator with sufficient privilege.
- h. Archival Storage of Data: Show that data archiving is handled by the operator workstation/server, and local trend archiving and display is accomplished with BACnet Trend Log objects.
- i. Modification of Trend Log Object Parameters: Show that an operator with sufficient privilege can change the logged data points, sampling rate, and trend duration.
- j. Device and Network Management: Show the following capabilities:
 - (1) Display of Device Status Information
 - (2) Display of BACnet Object Information
 - (3) Silencing Devices that are Transmitting Erroneous Data
 - (4) Time Synchronization
 - (5) Remote Device Reinitialization
 - (6) Backup and Restore Device Programming and Master Database(s)
 - (7) Configuration Management of Half-Routers, Routers and BBMDs

3.5.12 Execution of Sequence of Operation

Demonstrate that the HVAC system operates properly through the complete sequence of operation. Use read/write property services to globally read and modify parameters over the internetwork.

3.5.13 Control Loop Stability and Accuracy

For all control loops tested, give the Government trend graphs of the control variable over time, demonstrating that the control loop responds to a 20 percent sudden change of the control variable set point without excessive overshoot and undershoot. If the process does not allow a 20 percent set point change, use the largest change possible. Show that once the new set point is reached, it is stable and maintained. Control loop trend data shall be in real-time with the time between data points 30 seconds or less.

3.5.14 [Performance Verification Testing Report](#)

Upon successful completion of the PVT, submit a PVT Report to the Government and prior to the Government taking use and possession of the facility. Do not submit the report until all problems are corrected and successfully re-tested. The report shall include the annotated PVT Plan

used during the PVT. Where problems were identified, explain each problem and the corrective action taken. Include a written certification that the installation and testing of the control system is complete and meets all of the contract's requirements.

3.5.15 Bus Waveform Report

Provide printed wave form of the MS/TP bus(es). Use an oscilloscope to test and record the wave form of each bus segment complete with graphic scale. This wave form is useful in identifying and troubleshooting bus problems such as inappropriate taps, grounds, end of line terminations and poor connections. Identify each waveform graphic with bus segment name/number, location/building, date and time, and instrument used. Include the resistor sizes needed at each Bus End of Line (EOL). Include a list of the EOL devices. Waveform will be field verified government prior to BOD.

3.5.16 Sequencing of Performance Verification Testing Activities

PVT activities must be sequenced with major activities listed below for Test and Balance (TAB) Contractor, Equipment Suppliers, Commissioning Specialists, and others to demonstrate fully functioning systems. Complete the items in TABLE I: SEQUENCING OF PVT TESTING ACTIVITIES as schedule activities or milestones.

TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES	
SEQUENCE	ITEM
1	Submission, review, and approval of Control Contractors PVT Plans.
2	Submission, review, and approval of Equipment Suppliers PVT Plans.
3	Submission, review, and approval of certified final Test and Balance Report.
4	Conduct Test and Balance verification field work.
5	Governments written approval of Test and Blance verification field work.
6	Conduct commissioning functional performance tests.
7	Submission, review, and approval of all the Commissioning Specialists completed functional performance tests.
8	Request Contracting Officer to allow beginning of Government-witnessed PVT testing.
9	Contracting Officers approval to begin PVT testing.
10	Conduct PVT field work.

TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES	
SEQUENCE	ITEM
11	Governments verbal approval of PVT field work for all systems.
12	Submission, review, and approval of endurance testing.
13	Governments written approval of PVT field work for all systems.
14	Facility acceptance recommendation.
15	Submission, review, and approval of Control Contractors PVT Report.
16	Submission, review, and approval of Equipment Suppliers PVT Report.
17	Conduct applicable re-testing and seasonal testing within 10 months of beneficial occupancy.

3.5.16.1 PVT Testing for Multi-Phase Construction

For air moving systems except outside air systems serving multiple phases, all major activities listed in TABLE I through Government's verbal approval of Test and Balance verification field work can be completed by phase if all ductwork construction is completed for that phase.

For primary systems such as chilled water systems, HVAC heating hot water systems, and outside air systems serving multiple phases, all major activities listed listed in TABLE I through Government's verbal approval of Test and Balance verification field work for all air moving systems served by that primary system for that phase must be completed prior to conducting PVT field work for that primary system.

3.5.17 Performance Verification Testing Acceptance Testing Season One

Season 1 is determined by the outdoor conditions that are occurring once the project HVAC and DDC controls are initially completed and ready for PVT. Conversely, Season 2 is defined as the opposite outdoor conditions from Season 1. Season 1 could be either the season of maximum heating load, or the season of maximum cooling load. The Season of maximum cooling load is the time of year when the outdoor temperature at the project site remains above 85 degrees Fahrenheit dry bulb and 76 degrees Fahrenheit wet bulb for at least 8 consecutive hours during the period of DDC data recording. The season of maximum cooling load shall fall within June, July, August, or September. The Season of maximum heating load is the time of year when the outdoor temperature at the project site remains below 45 degrees Fahrenheit for at least 8 consecutive hours during the period of DDC data recording.

After acceptance of the PVT Report, demonstrate proper and stable operation of the DDC System. During the field acceptance testing, verify, in the presence of the COTR and BAS owner, random selections of sequences reported in the PVT Report. Equipment, controllers, devices, and sequences for field acceptance testing are to be selected by the COTR.

As-built control drawings must be for use and verification at acceptance testing. Field acceptance testing includes verification of the PVT for the following equipment groups:

Group 1: All pumps, chillers, boilers, return fans, computer room units, and air handling units (rooftop and central stations).

Group 2: 100 percent of terminals such as VAV and fan coil units.

Group 3: 100 percent of supply fans, and exhaust fans.

If any of the acceptance testing is found to not operate correctly, terminate verification for the given group. Make the necessary corrections and prepare a revised PVT Report. Reschedule acceptance testing of the revised report with the COTR. After the PVT has been accepted, submit the revised controller files and BACnet Building Controller database.

3.5.18 Performance Verification Testing Acceptance Testing Season Two

A minimum of 3 months after initial acceptance of the DDC system and in the opposite season of heating and cooling, demonstrate proper and stable operation of the DDC system. During the field acceptance testing, verify, in the presence of the COTR and BAS owner, random selections of sequences reported in the PCT Report. Equipment, controllers, devices, and sequences for field acceptance testing are to be selected by the COTR. Field acceptance testing includes verification of the PVT for the following equipment groups:

Group 1: All pumps, chillers, boilers, return fans, computer room units, and air handling units (rooftop and central stations).

Group 2: 100 percent of terminals such as VAV and fan coil units.

Group 3: 100 percent of supply fans, and exhaust fans.

If any of the acceptance testing is found to not operate correctly, terminate verification for the given group. Make the necessary corrections and prepare a revised PVT Report. Reschedule acceptance testing of the revised report with the COTR. After the PVT has been accepted, submit the revised controller files and BACnet Building Controller database.

3.6 TRAINING REQUIREMENTS

Provide a qualified instructor (or instructors) with two years minimum field experience with the installation and programming of similar BACnet DDC systems. Orient training to the specific systems installed. Coordinate training times and location with the Contracting Officer and BAS Owner after receiving approval of the training course documentation. Training shall take place at the job site or a nearby Government-furnished location. A training day shall occur during normal working hours, last no longer than 8 hours and include a one-hour break for lunch and two additional 15-minute breaks. The project's approved Controls System Operators Manual shall be used as the training text. The Contractor shall ensure the manuals are submitted, approved, and available to hand out to the trainees before the start of training.

3.6.1 Training Documentation

Submit training documentation, including contractor's training certifications, for review 30 days minimum before training. Documentation shall include an agenda for each training day, objectives, a synopsis of each lesson, and the instructor's background and qualifications. The training documentation can be submitted at the same time as the project's Controls System Operators Manual.

3.6.2 Phase I Training - Fundamentals

The Phase I training session shall last one day and be conducted in a classroom environment with complete audio-visual aids provided by the contractor. Provide each trainee a printed 8.5 by 11 inch hard-copy of all visual aids used. Upon completion of the Phase I Training, each trainee should fully understand the project's DDC system fundamentals. Approved As-Built control drawings must be used for training. The training session shall include the following:

- a. BACnet fundamentals (objects, services, addressing) and how/where they are used on this project
- b. This project's list of control system components
- c. This project's list of points and objects
- d. This project's device and network communication architecture
- e. This project's sequences of control, and:
- f. Alarm capabilities
- g. Trending capabilities
- h. Troubleshooting communication errors
- i. Troubleshooting hardware errors

3.6.3 Phase II Training - Operation

Provide Phase II Training shortly after completing Phase I Training. The Phase II training session shall last one day and be conducted at the DDC system workstation, at a notebook computer connected to the DDC system in the field, and at other site locations as necessary. Upon completion of the Phase II Training, each trainee should fully understand the project's DDC system operation. The training session shall include the following:

- a. A walk-through tour of the mechanical system and the installed DDC components (components include but are not limited to the following: controllers, valves, dampers, surge protection, switches, thermostats, and sensors)
- b. A discussion of the components and functions at each DDC panel
- c. Logging-in and navigating at each operator interface type
- d. Using each operator interface to find, read, and write to specific controllers and objects

- e. Modifying and downloading control program changes
- f. Modifying setpoints
- g. Creating, editing, and viewing trends
- h. Creating, editing, and viewing alarms
- i. Creating, editing, and viewing operating schedules and schedule objects
- j. Backing-up and restoring programming and data bases
- k. Modifying graphic text, backgrounds, dynamic data displays, and links to other graphics
- l. Creating new graphics and adding new dynamic data displays and links
- m. Alarm and Event management
- n. Adding and removing network devices

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

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 B109.4 | (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 | (2009; Addenda A 2012, Addenda B 2013; R 2019) Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves |
| ANSI Z21.18/CSA 6.3 | (2007; R 2017) Gas Appliance Pressure Regulators |
| ANSI Z21.21/CSA 6.5 | (2015) Automatic Valves for Gas Appliances |
| ANSI Z21.24/CSA 6.10 | (2015; Errata 2017) 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 | (2009; Addenda A 2012; R 2014) Connectors for Movable Gas Appliances |
| ANSI Z21.80/CSA 6.22 | (2019) Line Pressure Regulators |

ANSI Z21.93/CSA 6.30

(2017) Excess Flow Valves for Natural Gas
and Propane Gas with Pressures up to 5 psig

AMERICAN PETROLEUM INSTITUTE (API)

API RP 2003

(2015; 8th Ed) Protection Against
Ignitions Arising out of Static,
Lightning, and Stray Currents

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 B1.1

(2003; R 2018) Unified Inch Screw Threads
(UN and UNR Thread Form)

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 B16.5

(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 B16.21

(2021) Nonmetallic Flat Gaskets for Pipe
Flanges

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 B16.39

(2020) Standard for Malleable Iron
Threaded Pipe Unions; Classes 150, 250,
and 300

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 B31.8 (2018; Supplement 2018) Gas Transmission and Distribution Piping Systems

ASME BPVC SEC VIII D1 (2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM 01.01 (2019) Steel - Piping, Tubing, Fittings

ASTM A53/A53M (2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

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 (2018) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both

ASTM A513/A513M (2019) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing

ASTM F2015 (2000; R 2013) Standard Specification for Lap Joint Flange Pipe End Applications

CSA GROUP (CSA)

ANSI LC 1/CSA 6.26 (2019) Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)

FM GLOBAL (FM)

FM APP GUIDE (updated on-line) Approval Guide
<http://www.approvalguide.com/>

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) Liquefied Petroleum Gas Code

NFPA 70 (2023) National Electrical Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA 1981 (2008) Seismic Restraint Manual Guidelines
for Mechanical Systems, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101 (2014; Rev C) Color Code for Pipelines and
for Compressed Gas Cylinders

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. Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section, with additions and modifications specified herein. Provide cathodically protected insulating joints connecting aboveground piping from the meter to the building, with lightning arrestors conforming to API RP 2003, installed where indicated.

1.3.1 Gas Facility System and Equipment Operation

Include shop drawings showing piping layout, locations of system valves, gas line markers and cathodic protection system; step-by-step procedures for system start up, operation and shutdown (index system components and equipment to the system drawings); isolation procedures including valve operation to shutdown or isolate each section of the system (index valves to the system maps and provide separate procedures for normal operation and emergency shutdown if required to be different). 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" 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-02 Shop Drawings

Gas Piping System; G

SD-03 Product Data

Pipe and Fittings; G

Gas Equipment Connectors; G

Gas Piping System; G

Pressure Regulators; G

Valves; G

SD-06 Test Reports

Testing; G

Pressure Tests; G

Test with Gas; G

SD-07 Certificates

SD-08 Manufacturer's Instructions

SD-10 Operation and Maintenance Data

Gas Facility System and Equipment Operation; G

Gas Facility System Maintenance; G

Gas Facility Equipment Maintenance; G

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. [Provide pipe and fittings submittal data.](#)

2.2 [GAS PIPING SYSTEM](#) AND FITTINGS

2.2.1 Steel Pipe, Joints, and Fittings

- a. Pipe: Black carbon steel in accordance with [ASTM A53/A53M](#), Schedule 40, threaded ends for sizes 2 inches and smaller; otherwise, plain end beveled for butt welding.
- b. Threaded Fittings: [ASME B16.3](#), black malleable iron.
- c. Socket-Welding Fittings: [ASME B16.11](#), forged steel.
- d. Butt-Welding Fittings: [ASME B16.9](#), with backing rings of compatible material.
- e. Unions: [ASME B16.39](#), black malleable iron.
- f. Flanges and Flanged Fittings: [ASME B16.5](#) steel flanges or convoluted steel flanges conforming to [ASME BPVC SEC VIII D1](#), with flange faces having integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.

2.2.2 Steel Tubing, Joints and Fittings

Provide steel tubing conforming to [ASTM 01.01](#), and [ASTM A513/A513M](#), with tubing joints made up with gas tubing fittings recommended by the tubing manufacturer.

2.2.3 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](#).

2.2.4 Flange Gaskets

Provide gaskets of nonasbestos compressed material in accordance with

ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type, containing aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service, to be used for hydrocarbon service.

2.2.5 Pipe Threads

Provide pipe threads conforming to ASME B1.20.1.

2.2.6 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.

2.2.7 Insulating Pipe Joints

2.2.7.1 Insulating Joint Material

Provide insulating joint material between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

2.2.7.2 Threaded Pipe Joints

Provide threaded pipe joints of steel body nut type dielectric unions with insulating gaskets.

2.2.7.3 Flanged Pipe Joints

Provide joints for flanged pipe consisting of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts. Provide lap joint flange pipe ends conforming to ASTM F2015.

2.2.8 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 as indicated in the drawings 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 Z21.18/CSA 6.3 for appliances , and 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 and ANSI Z21.21/CSA 6.5 for automatic shutoff valves for gas appliances.

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. Adjust regulators for liquified petroleum gas to 2.5 to 3 kPa 10 to 12 inches of water column, with pressure relief set at 4 kPa 16 inches of water column.
- c. 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.

2.7 SEISMIC PROVISIONS

Provide earthquake automatic gas shutoff valve conforming to ASCE 25-16, SMACNA 1981 or excess flow valve (EFV) conforming with ANSI Z21.93/CSA 6.30 and UL listed or AGA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The earthquake valve may be either pendulum or ball construction with remote electronic actuator. The EFV may be either a bypass (automatic reset) or a non-bypass type (manual reset).

2.8 AUTOMATIC GAS SHUT-OFF

Provide low pressure automatic gas shutoff or excess flow valve (EFV) downstream of the point of delivery after the meter/regulator conforming to ANSI Z21.93/CSA 6.30 and UL listed or CSA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The EFV may be either a bypass (automatic reset) or a non-bypass type (manual reset).

2.9 BOLTING (BOLTS AND NUTS)

Stainless steel bolting; [ASTM A193/A193M](#), Grade B8M or B8MA, Type 316, for bolts; and [ASTM A194/A194M](#), Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts must conform with [ASME B18.2.1](#) and [ASME B18.2.2](#) with coarse threads conforming to [ASME B1.1](#), with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts or bolt-studs must extend through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Bolts must have American Standard regular square or heavy hexagon heads; nuts must be American Standard heavy semifinished hexagonal.

2.10 GASKETS

Fluorinated elastomer, compatible with flange faces.

2.11 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 GAS PIPING SYSTEM

Provide a gas piping system from the point of delivery, defined as the outlet of the meter set assembly, as specified under "Gas Service" within this specification, to the connections to each gas utilization device that is in compliance with [NFPA 54](#)..

3.2.1 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.

3.2.2 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.

3.3 PROTECTIVE COVERING

3.3.1 Aboveground Metallic Piping Systems

3.3.1.1 Ferrous Surfaces

Touch up shop primed surfaces with ferrous metal primer. Solvent clean surfaces that have not been shop primed. Mechanically clean surfaces that contain loose rust, loose mill scale and other foreign substances by power wire brushing and prime with ferrous metal primer or vinyl type wash coat. Finish primed surfaces with two coats of exterior oil paint or vinyl paint.

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. On steel pipe 6 inches and larger, an approved gas cutting and beveling machine may be used. Cut thermoplastic and fiberglass pipe in accordance with AGA XR0603.

3.4.1 Metallic Piping Installation

Bury underground piping a minimum of 18 inches below grade. 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 in exterior locations or underground.

3.4.2 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.

3.4.2.1 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.

3.4.3 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.

3.4.4 Final Gas Connections

Unless otherwise specified, make final connections with rigid metallic

pipe and fittings. Provide accessible gas shutoff valve and coupling for each gas equipment item.

3.4.5 Seismic Requirements

Support and brace piping and attached valves to resist seismic loads in conformance with [ASCE 25-16](#). CSST tubing and fittings that are seismically qualified in accordance with the [FM APP GUIDE: Flexible Piping Systems for Flammable Gases](#) must meet the seismic requirements in accordance with the manufacturer's installation instructions.

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 Welded Metallic Joints

Conform beveling, alignment, heat treatment, and inspection of welds to [NFPA 54](#). Remove weld defects and make repairs to the weld, or remove the weld joints entirely and reweld. After filler metal has been removed from its original package, protect and store so that its characteristics or welding properties are not affected adversely. Do not use electrodes that have been wetted or have lost any of their coating.

3.5.3 Solder or Brazed Joints

Make all joints in metallic tubing and fittings with materials and procedures recommended by the tubing supplier. Braze joints with material having a melting point above [1000 degrees F](#), containing no phosphorous.

3.5.4 Press Connections

Make press connections in accordance with manufacturer's installation instructions using tools approved by the manufacturer. Fully insert the tubing into the fitting and then mark at the shoulder of the fitting. Check the fitting alignment against the mark on the tubing to assure the tubing is fully inserted before the joint is pressed.

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, floor or roof, and cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Extend sleeves in

mechanical room floors above grade at least 4 inches above finish floor. 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 PIPES PENETRATING WATERPROOFING MEMBRANES

Install pipes penetrating waterproofing membranes as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.8 FIRE SEAL

Fire seal all penetrations of fire rated partitions, walls and floors in accordance with Section 07 84 00 FIRESTOPPING.

3.9 ESCUTCHEONS

Provide escutcheons for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

3.10 SPECIAL REQUIREMENTS

Provide drips, grading of the lines, freeze protection, and branch outlet locations as shown and conforming to the requirements of NFPA 54.

3.11 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.

3.12 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.

3.13 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.

3.14 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.

3.15 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.

3.16 GAS SERVICE INSTALLATION

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.

3.17 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.

3.17.1 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.

3.17.2 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.

3.17.3 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.

3.17.4 Labor, Materials and Equipment

Furnish all labor, materials and equipment necessary for conducting the testing and purging.

3.18 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 --

SECTION 23 21 13.00 20

LOW TEMPERATURE WATER (LTW) HEATING SYSTEM

04/06, CHG 2: 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.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

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 B16.24	(2016) Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.36	(2020) Orifice Flanges
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

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1017	(2009) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes
-----------	---

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) 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 B32	(2020) Standard Specification for Solder Metal
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM F1007	(2018) Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2019) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook
-----------	------------------------------------

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-67	(2017; Errata 1 2017) Butterfly Valves
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-70	(2011) Gray Iron Gate 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
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

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	(2018) Motors and Generators

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-V-12003	(1980; Rev F; Am 1; CANC Notice 1) Valves, Plug, Cast-Iron or Steel, Manually Operated
-------------	--

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-H-191	(Rev E; Notice 2) Heater, Fluid, Industrial (Instantaneous, Steam, Water Converter Type)
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 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.3 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).

1.3.1 Hot Water Heating System

Submit plan, elevations, dimensions, capacities, and ratings. Include the following:

- d. Pumps
- e. Valves
- f. Expansion tanks
- g. Flow measuring equipment
- h. Backflow preventer
- i. Air separating tank
- l. Converters

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Hot water heating system

SD-03 Product Data

Pumps

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

Flow measuring equipment

External air separation tanks

Hot water heating pipe

SD-06 Test Reports

Hydrostatic test of piping system

Auxiliary equipment and accessory tests

Submit test reports in accordance with the paragraph entitled "Field Quality Control."

SD-07 Certificates

Backflow preventer certification

Report of prior installations

Welding procedures

Welder's qualifications

1.5 QUALITY ASSURANCE

1.5.1 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.

1.5.2 Welding

1.5.2.1 Report of Prior Installations

Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project. Certificate shall be from the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California, and shall attest that this design, size, and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval is not acceptable in lieu of the above.

1.5.2.2 Welding Procedures

Before performing welding, submit three copies of welding procedure specification for all metals to be used in the work, together with proof of welder's qualification as outlines in [ASME B31.9](#).

1.5.2.3 Welder's Qualifications

Before welder or operator performs welding, submit three copies of Welder's Performance Qualification Record in conformance with [ASME B31.9](#) showing that the welder was tested under the approved procedure specification submitted by the Contractor. In addition, submit each welder's assigned number, letter, or symbol used to identify the work of the welder.

1.5.2.4 Identification of Welder's Work

Ensure that each welder's assigned number, letter or symbol is affixed immediately upon completion of the weld. To welders making defective welds after passing a qualification test, give a requalification test. Upon failing to pass the test, do not permit welder to work in this contract.

1.5.2.5 Previous Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for this contract without requalification subject to the approval and provided that all the conditions specified in [ASME B31.9](#) are met before a procedure can be used.

1.5.3 Brazing and Soldering

1.5.3.1 Brazing Procedure

[ASME B31.9](#). Brazing procedure for joints shall be as outlined in [CDA A4015](#).

1.5.3.2 Soldering, Soldering Preparation, and Procedures for Joints

[ASME B31.9](#) and as outlined in [CDA A4015](#).

1.5.4 Backflow Preventer Certification

Submit a Certificate of Full Approval or a current Certificate of Approval for backflow preventers.

1.6 SAFETY STANDARDS

1.6.1 Welding

Safety in welding and cutting of pipe shall conform to [AWS Z49.1](#).

1.6.2 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 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 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 Copper Tubing

Provide [CID A-A-59617](#), bronze unions, solder joint end.

2.1.1.3.2 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.

2.1.1.4 Flanges

Remove raised faces when used with flanges having a flat face.

2.1.1.4.1 Bronze Screwed Flanges

ASME B16.24.

2.1.1.5 Drains and Overflows

2.1.1.5.1 Copper Tubing

ASTM B88, Type L, hard drawn, cast brass or wrought copper fittings, Grade Sb5 solder joints.

2.1.1.6 Valves

Valves shall have rising stems and shall open when turned counterclockwise.

2.1.1.6.1 Gate Valves

- a. Bronze Gate Valves: MSS SP-80, 2 inches and smaller, wedge disc, inside screw type not less than Class 150. Use solder joint ends with copper tubing.
- c. Cast Iron Gate Valves: MSS SP-70, 2 1/2 inches and larger, open stem and yoke type with bronze trim.

2.1.1.6.2 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.
- c. Cast Iron Globe and Angle Valves: MSS SP-85, 2 1/2 inches and larger, with bronze trim, tapped drains and brass plug.

2.1.1.6.3 Check Valves

- a. Bronze Check Valves: MSS SP-80, 2 inches and smaller, regrinding swing check type, Class 200.
- c. Cast Iron Check Valves: ASME B16.34, 2 1/2 inches and larger, bronze trim, non-slam, eccentric disc type for centrifugal pump discharge service.

2.1.6.4 Temperature Regulating Valves

Provide ASSE 1017 copper alloy body with adjustable range thermostat.

2.1.6.5 Water Pressure-Reducing Valves

ASSE 1003.

2.1.6.6 Plug Valves

MIL-V-12003, except that a replaceable valve seat will not be required.
Type II - non-lubricated, lift-plug valves.

2.1.6.7 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.

2.1.6.8 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.

2.1.6.9 Butterfly Valves

Conform with MSS SP-67, Type I - Tight shut off valve, and flanged valve ends. Valve body material shall be cast iron and shall be bubble tight for shutoff at 150 psig. Flanged and flangeless type valves shall have Type 300 series corrosion resistant steel stems and corrosion resistant or bronze discs with molded elastomer disc seals. Flow conditions shall be for the regulation from maximum flow to complete shutoff by way of throttling effect. Valves shall be provided in closed system. Valves smaller than 8 inches shall have throttling handles. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and indicators. Valves shall have a minimum of 7 locking positions and shall be suitable for water temperatures up to 200 degrees F.

2.1.6.10 Butterfly Valves 2 Inches and Smaller

Valves shall be one-piece and three-piece design with male or female threaded or soldered end connections and shall be bubble tight for shutoff at 150 psig. Stem and disc assembly shall be of 300 series corrosion resistant steel. Disc seal assembly shall be of 300 series corrosion resistant steel. Disc seal shall be suitable for the liquid being used in the system in which the valve is to be installed. Valves shall be suitable for water temperature up to 200 degrees F and shall be capable of operating at the rated pressure of 150 psig. Valves shall be designed for throttling service use by valve lever and indicator adjustment.

2.1.6.11 Relief Valves

Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.1.6.12 Valve Operating Mechanisms

Provide power operators and extension stems where indicated and as specified.

- c. Power Operators: Shall be electric . Power operated valves shall open and close at rates no slower than 10 inches per minute for gate valves and 4 inches per minute for globe and angle valves. Valves shall open fully or close tightly without requiring further attention when the actuating control is moved to the open or close position. A predetermined thrust exerted on the stem during operation resulting from an obstruction in the valve shall cause the motor to automatically stop. Power operators shall be complete with all gearing and controls necessary for the size of valve being provided. Power operators shall be designed to operate on the electric power supply indicated.
- d. Extension Stem: Corrosion resisting steel designed for rising and non-rising stems. Provide in length required to connect the valve stem and the operating mechanism and of sufficient cross section to transfer the torque required to operate the valve.

2.1.6.13 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.

2.1.7 End Connections

2.1.7.1 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 flanged 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.

2.1.7.2 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).

- b. Copper Tube Extracted Joint: An extracted mechanical tee joint may be made in copper tube. Make joint 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, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to assure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints shall not be permitted.

2.1.8 Expansion Joints

2.1.8.1 Packless Type

Provide [ASTM F1120](#), Type III with fabricated corrosion-resistant steel bellows.

2.1.8.2 Guided Slip-Tube Type

Provide [ASTM F1007](#), Type IV internally-externally guided, injected semiplastic type packing.

2.1.9 Instrumentation

2.1.9.1 Pressure and Vacuum Gauges

Provide [ASME B40.100](#) with restrictor.

2.1.9.2 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.

2.1.9.3 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.

2.1.10 Miscellaneous Pipeline Components

2.1.10.1 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.

2.1.10.2 Strainers

Strainers for classes 125 and 250 piping in IPS 1/2 to 8 inches, inclusive, [FS WW-S-2739](#) and locate as indicated.

2.1.10.3 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.

If ferrous materials are used, provide hot dipped galvanized hangers, inserts and supports.

2.1.10.4 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](#).

2.1.10.5 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 Converters

Steam to hot water converters shall conform to [FS WW-H-191](#) and shall have capacity as indicated for the design conditions. The converters shall be designed for support by separate pipe hangers, and temperature regulator [and](#) vent valve shall be provided.

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 type conforming to [NEMA MG 1](#) and suitable for electrical characteristic as indicated. Motor starters shall conform to [NEMA ICS 2](#) across the line type with [NEMA ICS 6](#) general purpose enclosure.

2.3.2 Expansion Tanks

Provide welded steel, constructed and tested hydrostatically in accordance with [ASME BPVC SEC VIII D1](#). Tank shall be equipped with all necessary

fittings. The tank and fittings shall be pressure rated at least equal to the test pressure of the total system. Zinc coat the tank inside and out after fabrication by the hot dip process [ASTM A123/A123M](#).

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.

2.3.4 Flow Measuring Equipment

Orifice or venturi type. Flow metering equipment including pitot tubes, venturis, orifice plates, flanges, and indicating meters shall be the product of one and the same manufacturer. Provide flowmeters of permanent type. Flowmeters shall be suitable for service in which they are to be installed. Primary elements of flowmeters shall conform to ASME recommendations for flowmeters. Provide bronze, monel, or stainless steel materials for wetted parts of flow meters.

- a. Orifices: Square-edge type, made of corrosion and erosion resistant metal and mounted between pipe flanges having factory-made pressure taps provided with shutoff valves. Orifice flanges shall conform to [ASME B16.36](#).
- b. Tubular Flowmeters: Flow measuring elements consisting of venturi tubes or pitot tubes where indicated. Locations and arrangement of piping, both upstream and downstream of flow measuring elements shall conform to the manufacturer's published literature. Provide each flow measuring element with an integral tab, or a metal tag on a corrosion-resistant steel wire, extending outside pipe covering, and stamped or printed in a visible position with manufacturer's name and address; serial number of meter to which it is to be connected; name, number, or location of equipment served; specified rate of flow; and multiplier to be applied to meter reading. Provide taps with shutoff valves and quick connecting hose fittings for portable meters or double ferrule compression fittings for connection to tubing for permanently located meters or recorders. Tubes shall be calibrated in accordance with ASME recommendations.
 - (1) Venturi Tubes: Certified by the manufacturer for the actual piping configuration and any necessary piping changes required for certification without additional cost to the Government. Throat diameter for each venturi tube shall be designed so that at specified rate of flow the scale reading will fall between 50 percent and 80 percent of full scale value. Select venturi tube sizes from the manufacturer's latest published tables of flow versus differential pressure. Unrecovered head loss at maximum flow shall not exceed 10 percent. Provide bronze or cast iron tubes with bronze-lined throats, with flanged, threaded, or welded ends to suit piping system. Provide bodies of fabricated steel and fittings of the same class as piping in which installed. Two integral meter taps shall be provided in each venturi tube. Connections for attachment to portable flow meter hoses shall be

readily accessible and not over 6 feet above a floor or permanent platform.

- (2) Pitot Tube Assemblies: Provide corrosion-resistant materials. Tubes shall be capable of measuring liquid flow through tube elements providing an averaged, interpolated flow measurement from a single, fixed position. Provide self cleaning elements and impact tube designed to rotate when turned by the operator to protect pressure-sensing elements of tube when not in use. Location and total amount of pitot tubes required for system flow measurement shall be as recommended by the manufacturer and as indicated.

- c. Meters: Designed for a full scale pressure differential of 50 inches water gage for tubular type or 100 inches water gage for orifice type. Dials shall have square root or linear scales with developed length of not less than 12 inches. Provide flush mounted panel meters that read directly in gallons per minute. Dials of portable meters shall have square root scales reading from 0 to 100 gpm for use with multiplier stamped on orifice or tubular type. Provide meters designed for not less than 200 psi and protected against pressure surges. Meter bodies shall have taps for venting and draining.

- (1) Permanently Mounted Meters: Each meter shall be connected completely as indicated and as specified and provided with the following: three valve manifold equalizer lines, two block valves, two vent and drain valves, and an integral pulsation damper. Overall accuracy of meters shall be plus or minus 2 percent of full scale flow over a range from 20 to 100 percent of full scale flow.

2.4 TERMINAL UNITS

2.4.1 Heating and Ventilating Units

Provide fan-coil units as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5 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.

2.6 CONTROLS

Provide controls as specified in Section 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.

2.7 INSULATION

Provide shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8 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 and expansion joints where they may be inspected. Provide flanged joints where necessary for normal maintenance and where required to match valves and equipment. Furnish gaskets, packing, and thread compounds suitable for the service. Provide long radius ells where possible to reduce pressure drops. Pipe bends in lieu of welding fittings may be used where space permits. Pipe bends shall have a uniform radius of at least five times the pipe diameter and shall be free from appreciable flattening, wrinkling, or thinning of the pipe. Do not use mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction. Make branch connections over [2 inches](#) with welding tees except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to [ASME B31.9](#) may be used, provided the nominal diameter of the branch is at least one pipe size less than the nominal diameter of the run. Branch connections [2 inches](#) and under can be threaded or welded. 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. Sleeves in floor slabs shall extend [2 inches](#) above finished floor. 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 Flashing for Buildings

Provide flashing where pipes pass through building roofs, and make outside walls tight and waterproof.

3.2.5 Unions and Flanges

Provide unions and flanges to permit easy disconnection of piping and apparatus. Each connection having a screwed-end valve shall have a union. Place unions and flanges no farther apart than [100 feet](#). Install unions downstream of valves and at equipment or apparatus connections. Provide unions on piping under [2 inches](#) in diameter, and provide flanges on piping [2 inches](#) and over in diameter. 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.

3.2.6 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.

3.2.7 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. For pipe [2 inches](#) and larger, 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.

3.2.8 Valves

Install valves in conformance with [ASME B31.9](#). Provide gate valves unless otherwise directed. 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.

3.2.8.1 Globe Valves

Install globe valves so that the pressure is below the disk and the stem horizontal.

3.2.8.2 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.

3.2.9 Pressure Gage

Provide a shut-off valve between pressure gages and the line.

3.2.10 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.

3.2.11 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.

3.2.12 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. Install close coupled and base mounted pumps on concrete base, with anchor bolts, set and level, and grout in place and provide supports under elbows on pump suction and discharge line sizes 4 inches and over. Lubricate pump before start-up.

3.2.13 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.

3.2.14 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.

3.2.15 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.

3.2.16 Painting of Piping and Equipment

Provide in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.2.17 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 14 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.

3.3.2.1 Backflow Preventers

Backflow preventers shall be tested by locally approved and certified backflow assembly testers. A copy of the test report shall be provided to the Contracting Officer prior to placing the domestic water system into operation, or no later than 5 days after the test.

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 --

SECTION 23 23 00

REFRIGERANT PIPING
08/21

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.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 710 I-P	(2009) Performance Rating of Liquid-Line Driers
AHRI 720	(2002) Refrigerant Access Valves and Hose Connectors
AHRI 750 I-P	(2016) Performance Rating of Thermostatic Refrigerant Expansion Valves
AHRI 760 I-P	(2014) Performance Rating of Solenoid Valves for Use with Volatile Refrigerants
AHRI 1370 I-P	(2017) Performance Rating of Electronic Expansion Valves

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 17	(2015) Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves
ASHRAE 90.1 - IP	(2019; Errata 1 2019; Errata 2-5 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 6-8 2021; Interpretation 1-4 2020; Interpretation 5-8 2021 Addenda AS-AQ 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

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 B31.1	(2020) Power Piping
ASME B31.5	(2020) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS A5.31/A5.31M	(2012) Specification for Fluxes for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) 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 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 B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B280	(2020) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials

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

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Refrigerant Piping System; G

SD-03 Product Data

Refrigerant Piping System

Qualifications

Refrigerant Piping Tests

SD-06 Test Reports

Refrigerant Piping Tests

SD-07 Certificates

Service Organization

SD-10 Operation and Maintenance Data

Maintenance; G

Operation and Maintenance Manuals; G

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

Submit 4 copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations.

1.3.2 Contract 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.

1.4 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 is the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter.

1.5 MAINTENANCE

1.5.1 General

Submit Data Package 2 plus operation and maintenance data complying with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL 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 2 years prior to bid opening.
- b. The 2 year use must include applications of equipment and materials under similar circumstances and of similar size. The 2 years' experience must 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 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. Products must be supported by a [service organization](#). System components must be environmentally suitable for the indicated locations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. The service organizations must 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.
- d. Exposed equipment 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. Install safety devices so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with [AWS Z49.1](#).
- e. Provide the manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component. Highlight the data to show information such as, but not limited to, material, size, options, performance charts, and curves in adequate detail to demonstrate compliance with contract requirements. Include the manufacturer's recommended installation instructions and

procedures in the data provided. Provide data for the following components as a minimum:

- (1) Piping and Fittings
- (2) Valves
- (3) Piping Accessories
- (4) Pipe Hangers, Inserts, and Supports

2.2 ELECTRICAL WORK

Electrical equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Field wiring must be in accordance with manufacturer's instructions.

2.3 REFRIGERANT PIPING SYSTEM

Provide refrigerant piping, valves, fittings, and accessories in accordance with ASHRAE 15 & 34 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories must be compatible with the fluids used and capable of withstanding the pressures and temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service must be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant. Submit drawings, at least 5 weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements. Drawings must consist of:

- a. Piping layouts which identify all valves and fittings.
- b. Plans and elevations which identify clearances required for maintenance and operation.

2.4 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

2.4.1 Copper Tubing

Provide copper tubing conforming to ASTM B280 annealed or hard drawn as required. Copper tubing must bear the product identification markings in accordance with ASTM B280, "ACR" must be present on copper tubing. Copper tubing must be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing must not be used in sizes larger than 1-3/8 inches. Joints must be brazed except that joints on lines 7/8 inch and smaller may be flared. Cast copper alloy fittings for flared copper tube must conform to ASME B16.26 and ASTM B62. Wrought copper and bronze solder-joint pressure fittings must conform to ASME B16.22 and ASTM B75/B75M. Joints and fittings for brazed joint must be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings are not allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

2.4.2 Solder

Solder must conform to ASTM B32, grade Sb5, tin-antimony alloy for service pressures up to 150 psig. Solder flux must be liquid or paste form, non-corrosive and conform to ASTM B813.

2.4.3 Brazing Filler Metal

Filler metal must conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type FB3-A or Type FB3-C flux, except Type BCuP-3, BCuP-4, or BCuP-5 may be used for brazing copper-to-copper joints. BAlSi-4 with AWS Type FB1-A flux may be used when joining copper piping to aluminum components.

2.4.4 Brazing Flux

Brazing flux must conform to AWS A5.31/A5.31M, Type FB3-A or Type FB3-C when using Type BAg-5 filler metal. Type FB1-A is to be used with Type BAlSi-4 filler metal.

2.4.5 Press Fittings

Press fittings are not acceptable for use in refrigerant piping systems.

2.5 VALVES

Valves must be designed, manufactured, and tested specifically for refrigerant service. The valve material and all internal components must be compatible with the specific refrigerant and lubricant used. Valve bodies must be of brass or bronze construction. Valves 1 inch and smaller must have brazed or socket welded connections. Do not use threaded end connections, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts must be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere must be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow must be legibly and permanently indicated on the valve body. Control valve inlets must be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Purge, charge and receiver valves must be of manufacturer's standard configuration.

2.5.1 Refrigerant Stop Valves

Valve must be the globe or full-port ball type with a back-seating stem especially packed for refrigerant service. Valve packing must be replaceable under line pressure. Provide valve with a wrench operator and a seal cap. Valve must be the straight or angle pattern design as indicated.

2.5.2 Check Valves

Valve must be the swing or lift type as required to provide positive shutoff at the differential pressure indicated. Valve must be provided with resilient seat.

2.5.3 Liquid Solenoid Valves

Provide valves that comply with AHRI 760 I-P and are suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves must be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions must be furnished. Provide solenoid coils that are moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves must have safe working pressure of 610

psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Valves must have an operating pressure differential suitable for the refrigerant used.

2.5.4 Expansion Valves

Provide valve conforming to AHRI 750 I-P and ASHRAE 17. Valve must be the diaphragm and spring-loaded type with internal or external equalizers, and bulb and capillary tubing. Provide valve with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 2 degrees F of saturated suction temperature at evaporator conditions. Bulb charge must be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Do not use gas limited liquid charged valves and other valve devices for limiting evaporator pressure without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves must have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. Provide an isolatable pressure gauge in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicated or for constant evaporator loads.

2.5.5 Electronic Expansion Valves

Valve must conform to AHRI 1370 I-P and ASHRAE 17. The valve must prevent the return of liquid to the compressor in the event of power loss or low superheat.

2.5.6 Safety Relief Valves

Valve must be the two-way type, unless indicated otherwise. Valve must bear the ASME code symbol. Valve capacity must be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve must be of an automatically reseating design after activation.

2.5.7 Evaporator Pressure Regulators, Direct-Acting

Valve must include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve must maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load must not exceed the pressure difference corresponding to a 2 degrees F change in saturated refrigerant temperature at evaporator operating suction temperature. Spring must be selected for indicated maximum allowable suction pressure range.

2.5.8 Refrigerant Access Valves

Provide refrigerant access valves and hose connections in accordance with AHRI 720.

2.6 PIPING ACCESSORIES

2.6.1 Filter Driers

Driers must conform to AHRI 710 I-P. Sizes 5/8 inch and larger must be the full flow, replaceable core type. Sizes 1/2 inch and smaller must be the sealed type. Cores must be of suitable desiccant that will not plug, cake, dust, channel, or break down, and must remove water, acid, and foreign material from the refrigerant. Construct filter driers so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure must be 1,500 psi.

2.6.2 Sight Glass and Liquid Level Indicator

2.6.2.1 Assembly and Components

Assembly must be pressure- and temperature-rated and constructed of materials suitable for the service. Glass must be borosilicate type. Ferrous components subject to condensation must be electro-galvanized.

2.6.2.2 Gauge Glass

Gauge glass must include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

2.6.2.3 Bull's-Eye and Inline Sight Glass Reflex Lens

Provide bull's-eye and inline sight glass reflex lens for dead-end liquid service. For pipe line mounting, provide two plain lenses in one body suitable for backlighting viewing.

2.6.2.4 Moisture Indicator

Indicator must be a self-reversible action, moisture reactive, color changing media. Indicator must be furnished with full-color-printing tag containing color, moisture, and temperature criteria. Unless otherwise indicated, the moisture indicator must be an integral part of each corresponding sight glass.

2.6.3 Vibration Dampeners

Dampeners must be of the all-metallic bellows and woven-wire type.

2.6.4 Flexible Pipe Connectors

Connector must be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly must be constructed with a safety factor of not less than 4 at 300 degrees F. Unless otherwise indicated, the length of a flexible connector must be as recommended by the manufacturer for the service intended.

2.6.5 Strainers

Strainers used in refrigerant service must have brass or cast-iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe

diameter with pressure rating compatible with the refrigerant service. Screens must be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.6.6 Pressure and Vacuum Gauges

Provide gauges conforming to ASME B40.100 with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge must be a minimum of 3-1/2 inches in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Select each gauge range so that at normal operating pressure, the needle is within the middle-third of the range.

2.6.7 Pipe Hangers, Inserts, and Supports

Provide pipe hangers, inserts, guides, and supports conforming to MSS SP-58.

2.6.8 Escutcheons

Escutcheons must be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

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 3000 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

Factory installed insulation must be in accordance with ASHRAE 90.1 - IP. Refrigerant suction lines between the cooler and each compressor must be insulated with not less than 1/2 inch thick unicellular plastic foam. 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 25 and a smoke developed index no higher than 50. 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. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Test material supplied by a manufacturer with a jacket as a composite material. Provide jackets, facings, and adhesives that have a flame spread index less than 25 and a smoke developed index less than 50 when tested in accordance with ASTM E84.

PART 3 EXECUTION

3.1 INSTALLATION

Pipe and fitting installation must conform to the requirements of [ASME B31.1](#). 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 by reaming, and 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 must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

3.1.2 Functional Requirements

Install piping [1/2 inch/10 feet](#) of pipe in the direction of flow to ensure adequate oil drainage. Properly cap or plug open ends of refrigerant lines or equipment during installation to keep moisture, dirt, or other foreign material out of the system. Piping must remain capped until installation. Equipment piping must be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements must fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

3.1.3 Fittings and End Connections

3.1.3.1 Brazed Connections

Perform brazing in accordance with [AWS BRH](#), except as modified herein. During brazing, fill the pipe and fittings with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, clean both the outside of the tube and the inside of the fitting with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux on copper-to-copper connections. Remove surplus brazing material at all joints. Make steel tubing joints in accordance with the manufacturer's recommendations. Paint joints in steel tubing with the same material as the baked-on coating within 8 hours after joints are made. Protect tubing against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Support piping prior to brazing and do not spring or force.

3.1.4 Valves

3.1.4.1 General

Install refrigerant stop valves on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation

as required for maintenance or repair. Install stop valves with stems horizontal unless otherwise indicated. Install ball valves must be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches must be external to thermal insulation. Safety switches must not be fitted with isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves must be provided at all points of systems where accumulated non-condensable gases would prevent proper system operation. Valves must be furnished to match line size, unless otherwise indicated or approved.

3.1.4.2 Expansion Valves

Install expansion valves with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than $2\frac{1}{8}$ inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than $2\frac{1}{8}$ inches. Fasten the bulb securely with two clamps. Insulate the bulb. Install the bulb in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing must be facing up.

3.1.4.3 Valve Identification

Tag each system valve, including those which are part of a factory assembly. Tags must be in alphanumeric sequence, progressing in direction of fluid flow. Tags must be embossed, engraved, or stamped plastic or nonferrous metal of various shapes, sized approximately $1\frac{3}{8}$ inch diameter, or equivalent dimension, substantially attached to a component or immediately adjacent thereto. Attach tags with nonferrous, heavy duty, bead or link chain, 14 gauge annealed wire, nylon cable bands or as approved. Reference tag numbers in Operation and Maintenance Manuals and system diagrams.

3.1.5 Vibration Dampers

Provide vibration damper in the suction and discharge lines on spring mounted compressors. Install vibration dampers parallel with the shaft of the compressor and anchor firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.1.6 Strainers

Provide strainers immediately ahead of solenoid valves and expansion devices. Strainers may be an integral part of an expansion valve.

3.1.7 Filter Dryer

Provide a liquid line filter dryer on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Size dryers in accordance with the manufacturer's recommendations for the system in which it is installed. Install dryers such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Install dryers in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.1.8 Sight Glass

Install a moisture indicating sight glass in all refrigerant circuits downstream of all filter dryers and where indicated. Provide full line size sight glasses.

3.1.9 Discharge Line Oil Separator

Provide discharge line oil separator in the discharge line from each compressor. Connect the oil return line to the compressor as recommended by the compressor manufacturer.

3.1.10 Accumulator

Provide accumulators in the suction line to each compressor.

3.1.11 Flexible Pipe Connectors

Install connectors perpendicular to line of motion being isolated. Fit piping for equipment with bidirectional motion with two flexible connectors, in perpendicular planes. Install reinforced elastomer flexible connectors in accordance with manufacturer's instructions. Provide piping guides and restraints related to flexible connectors as required.

3.1.12 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports must conform to [MSS SP-58](#), except as modified herein. Do not use pipe hanger types 5, 12, and 26. Fabricate hangers used to support piping [2 inches](#) and larger to permit adequate adjustment after erection while still supporting the load. Support piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, by variable spring hangers and supports or by constant support hangers.

3.1.12.1 Hangers

Do not use Type 3 on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.12.2 Inserts

Secure Type 18 inserts 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.

3.1.12.3 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.

3.1.12.4 Angle Attachments

Furnish Type 20 attachments used on angles and channels with an added malleable-iron heel plate or adapter.

3.1.12.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, must be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Use Type 40 shields on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. Use a high-density insulation insert of cellular glass under the Type 40 shield for piping 2 inches and larger.

3.1.12.6 Horizontal Pipe Supports

Space horizontal pipe supports as specified in MSS SP-58 and install a support no more than 1 foot from the pipe fitting joint at each change in direction of the piping. Space pipe supports no more than 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds must have the excess hanger loads suspended from panel points.

3.1.12.7 Vertical Pipe Supports

Support vertical pipe 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.

3.1.12.8 Pipe Guides

Provide Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Provide slide materials that are suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.12.9 Steel Slides

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, use a Type 39 saddle. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.12.10 High Temperature Guides with Cradles

Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide must include a pipe cradle, welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

3.1.12.11 Multiple Pipe Runs

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 must not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.12.12 Structural Attachments

Attachment to building structure concrete and masonry must be by cast-in

concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors must be applied 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. Provide structural steel brackets required to support piping, headers, and equipment, but not shown, under this section. Specify material used for support under Section 05 12 00 STRUCTURAL STEEL.

3.1.13 Pipe Alignment Guides

Provide pipe alignment guides where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.14 Pipe Anchors

Provide anchors wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Provide anchors consisting of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results using turnbuckles where required. Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, immediately anchor these items adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Submit detailed drawings of pipe anchors for approval before installation.

3.1.15 Building Surface Penetrations

Do not install sleeves in structural members except where indicated or approved. Provide galvanized sheet metal sleeves in non-load bearing surfaces conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Provide uncoated carbon steel pipe sleeves in load bearing surfaces conforming to ASTM A53/A53M, Standard weight. Apply sealants to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Do not install sleeves in structural members.

3.1.15.1 General Service Areas

Extend each sleeve through its respective wall, floor, or roof, and cut flush with each surface. Provide pipes passing through concrete or masonry wall or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Provide sleeves that allow 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, seal the annular space between pipe and sleeve or between jacket over-insulation and sleeve in accordance with Section 07 92 00 JOINT SEALANTS.

3.1.15.2 Waterproof Penetrations

Install pipes passing through roof or floor waterproofing membrane through a 17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Form flashing sleeve, and extend skirt or flange greater than 8 inches from the pipe and set over the roof or floor membrane in a troweled coating of bituminous cement. Extend the

flashing sleeve up the pipe a minimum of 2 inches above the roof or floor penetration. Seal the annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation as indicated. Seal penetrations by either one of the following methods.

3.1.15.2.1 Waterproofing Clamping Flange

Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.1.15.2.2 Modular Mechanical Type Sealing Assembly

In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Provide seals consisting of 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. Loosely assemble links 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, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameters.

3.1.15.3 Fire-Rated Penetrations

Seal penetration of fire-rated walls, partitions, and floors as specified in Section 07 84 00 FIRESTOPPING.

3.1.15.4 Escutcheons

Provide escutcheons for finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, use special deep-type escutcheons. Secure escutcheon to pipe or pipe covering.

3.1.16 Access Panels

Provide access panels for all concealed valves, vents, controls, and items requiring inspection or maintenance. Provide access panels of sufficient size and locate so that the concealed items may be serviced and maintained or completely removed and replaced.

3.1.17 Field Applied Insulation

Field installed insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.1.18 Field Painting

Painting required for surfaces not otherwise specified, and finish

painting of items only primed at the factory are specified in Section
09 90 00 PAINTS AND COATINGS.

3.1.18.1 Color Coding

Color coding for piping identification is specified in Section 09 90 00
PAINTS AND COATINGS.

3.1.18.2 Color Coding Scheme

Provide a color coding scheme for locating hidden piping in accordance
with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.1.19 Identification Tags

Provide identification tags made of brass, engraved laminated plastic or
engraved anodized aluminum indicating service and item number on all
valves and dampers. Tags must be 1-3/8 inch minimum diameter and marking
must be stamped or engraved. Indentations must be black for reading
clarity. Attach tags to valves with No. 12 AWG copper wire, chrome-plated
beaded chain or plastic straps designed for that purpose.

3.2 CLEANING AND ADJUSTING

Clean uncontaminated system(s) by evacuation and purging procedures
currently recommended by refrigerant and refrigerant equipment
manufacturers, and as specified herein, to remove small amounts of air and
moisture. Systems containing moderate amounts of air, moisture,
contaminated refrigerant, or any foreign matter are considered
contaminated systems. Restore contaminated systems to clean condition
including disassembly, component replacement, evacuation, flushing,
purging, and re-charging, using currently approved refrigerant and
refrigeration manufacturer's procedures. Restore contaminated systems at
no additional cost to the Government as determined by the Contracting
Officer. Do not use water in any procedure or test.

3.3 TRAINING COURSE

- a. Submit 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. Conduct a training course for 6 members of the operating
staff as designated by the Contracting Officer. The training period
must consist of a total 4 hours of normal working time and start after
the system is functionally completed but prior to final acceptance
tests.
- b. Cover all of the items contained in the approved operation and
maintenance manuals.
- c. Submit 6 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. Include
the manufacturer's name, model number, and parts list in the
booklets. Include the manufacturer's name, model number, service
manual, and a brief description of all equipment and their basic
operating features in the manuals.
- d. Submit 6 complete copies of maintenance manual in bound 8 1/2 x 11 inch

booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. Include piping layouts and simplified wiring and control diagrams of the system as installed in the manuals.

3.4 REFRIGERANT PIPING TESTS

After all components of the refrigerant system have been installed and connected, subject the entire refrigeration system to pneumatic, evacuation, and startup tests as described herein. Submit a schedule, at least 2 weeks prior to the start of related testing, for each test. Identify the proposed date, time, and location for each test. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test. Provide the services of a qualified technician, as required, to perform all tests and procedures indicated herein. Coordinate field tests with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit 6 copies of the tests report in bound 8 1/2 by 11 inch booklets documenting all phases of the tests performed. Include initial test summaries, all repairs/adjustments made, and the final test results in the report.

3.4.1 Preliminary Procedures

Prior to pneumatic testing, isolate equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, from the test pressure, or remove from the system. Remove safety relief valves and rupture discs that are not part of factory sealed systems, and cap or plug openings.

3.4.2 Pneumatic Test

Provide pressure control and excess pressure protection at the source of test pressure. Valves must be wide open, except those leading to the atmosphere. Test gas must be dry nitrogen, with minus 70 degree F dewpoint and less than 5 ppm oil. Apply test pressure in two stages before any refrigerant pipe is insulated or covered. In accordance with ASME B31.5, a preliminary test not to exceed 25 psi must be applied as a means of locating major leaks. Every joint being tested must be coated with a thick soap or color indicating solution. The second stage test pressure must be at least 110 percent of the design pressure, but cannot exceed 130 percent of the design pressure of any component in the system. For large systems that are not completely visible, the pressure in the system must be gradually increased to one-half of the test pressure after which the pressure must be increased in steps of one-tenth of the test pressure, until the required test pressure has been reached. The test pressure must be continuously maintained for at least 24 hours, after which it can be reduced to the leak test pressure. A correction factor of 0.3 psi will be allowed for each degree F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. The leak test pressure must be the design pressure, or a pressure specified in the engineering design. To repair leaks, the joint must be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, re-melting, or back-welding/brazing are not acceptable. Following repair, the entire system must be retested using the pneumatic tests described above. Reassemble the entire system once the pneumatic tests are satisfactorily completed.

3.4.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, relieve the pressure and evacuate the entire system to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature must be higher than 35 degrees F. Do not evacuate no more than one system at one time by one vacuum pump. Once the desired vacuum has been reached, close the vacuum line and allow the system to stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, evacuate the system again down to 300 micrometers and let set for another 1 hour period. Do not charge the system until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure rises above 500 micrometers, continue to repeat the evacuation procedures until all residual moisture has been removed. During evacuation, record pressures by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

3.4.4 System Charging and Startup Test

Following satisfactory completion of the evacuation tests, charge the system with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system must operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. Test the entire system tested for leaks. Test fluorocarbon systems with halide torch or electronic leak detectors.

3.4.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must be immediately isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. The refrigerant must not be discharged into the atmosphere.

3.4.6 Contractor's Responsibility

At all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time will the allowable leak rate exceed the leak rates allowed in Section 608 of the Clean Air Act: 30 percent of the full charge per year for industrial refrigeration, 20 percent of the full charge per year for commercial refrigeration, and 10 percent of the full charge per year for comfort cooling. Any system leaks within the first year must be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

-- End of Section --

SECTION 23 25 00

CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS
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 within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100 (2013) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM D596 (2001; R 2018) Standard Guide for Reporting Results of Analysis of Water

ASTM D2688 (2015; E 2016) Standard Test Method for Corrosivity of Water in the Absence of Heat Transfer (Weight Loss Methods)

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Water Analysis; G

Spare Parts

Field Instructions

Tests; G

Training Course; G

1.3 MAINTENANCE MATERIAL SUBMITTALS

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings, not later than 3 months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with source of supply, with the data.

1.4 QUALITY CONTROL

1.4.1 Safety

Ensure 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 are 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 SYSTEM DESCRIPTION

2.1.1 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.

.

2.1.2 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. Include in the two-year use all applications of equipment and materials under similar circumstances and of similar size. Ensure the two years' experience has 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 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.
- c. All products are required to 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 are required to 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.

- d. The selected service organization provides the chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company provides all chemicals required for the chilled and hot water systems and fills the systems with chemicals to the levels specified. The chemical is required to meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and cooling tower. Acid treatment chemicals are not allowed to be used.

2.1.3 Water Analysis

Conditions of make-up water to be supplied to the hot and chilled water systems reported in accordance with ASTM D596 are as follows:

Date of Sample	_____
Temperature	_____ degrees C
Silica (SiO ₂)	_____ ppm (mg/L)
Insoluble	_____ ppm (mg/L)
Iron, total (Fe)	_____ ppm (mg/L)
Aluminum (Al)	_____ ppm (mg/L)
Calcium (Ca)	_____ ppm (mg/L)
Magnesium (Mg)	_____ ppm (mg/L)
Carbonate (HCO ₃)	_____ ppm (mg/L)
Sulfate (SO ₄)	_____ ppm (mg/L)
Chloride (Cl)	_____ ppm (mg/L)
Nitrate (NO ₃)	_____ ppm (mg/L)
Turbidity	_____ ntu
pH	_____
Residual Chlorine	_____ ppm (mg/L)
Total Alkalinity	_____ ppm (mg/L)
Non-Carbonate Hardness	_____ ppm (mg/L)
Total Hardness	_____ ppm (mg/L)
Dissolved Solids	_____ ppm (mg/L)

Conductivity	_____ Micromho/cm
--------------	-------------------

2.2 EQUIPMENT

2.2.1 Nameplates

Provide a nameplate for each major component of equipment that includes the manufacturer's name, address, type or style, and catalog or serial number securely attached to the item of equipment.

2.2.2 Gauges

Provide gauges that conform to ASME B40.100, Class 1, 2, or 3, Style X, Type I or III as required, 4-1/2 inches in diameter with phenolic or metal case.

2.3 COMPONENTS

2.3.1 Chilled Water System

Provide a 5 gallon shot feeder on the chilled water piping as indicated. Furnish the feeder with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.3.1.1 Chilled Water Treatment

Treat chilled water with either a borax/nitrite type treatment or a molybdate type treatment.

2.3.1.2 Chilled Water Test Kits

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals (e.g. pH and nitrite or molybdate).

2.3.2 Low and Medium Temperature Hot Water

2.3.2.1 Chemical Feeder

Provide a 5 gallon shot feeder on the hot water piping as indicated. Base the size and capacity of feeder upon local requirements and water analysis. Furnish the feeder with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.3.2.2 Low and Medium Temperature Hot Water Treatment

Treat hot water with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment are acceptable to use with glycol. Maintain borax/nitrite treatment 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. Maintain molybdate treatment 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.

2.3.2.3 Test Kit Requirements

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals (e.g. pH and nitrite or molybdate).

2.3.3 Test Kit

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals (e.g. pH, hardness and sulfite).

2.3.4 Supplemental Components/Services

Ensure drain and makeup water piping complies with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE. Connect drains to sanitary sewer systems by means of an indirect waste connection.

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.

3.2.1 Piping

Fabricate all connections between dissimilar metals using dielectric unions.

3.3 FIELD QUALITY CONTROL

3.3.1 Tests

If the waters of the mechanical systems are not in conformance with the specified requirements or in accordance with manufacturer's recommendations, the contractor is required to direct the water treatment company to take corrective action to achieve compliance. Perform daily operational tests 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/hot water quality tests. Identify the date, time, frequency and collection location for each test within the schedules.

3.3.2 Chilled Water Testing (monthly)

Perform the following tests on chilled water on a monthly basis.

pH	_____
Nitrite or Molybdate	_____ ppm (mg/L)
Conductivity	_____ micromho/cm

3.3.3 Hot Water Quality Testing

3.3.3.1 Low and Medium Temperature Systems (monthly)

Complete and record monthly testing for the following parameters.

pH	_____
Nitrite or Molybdate	_____ ppm (mg/L)

3.3.4 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.

3.3.4.1 Chilled Water Quality Assurance Testing (quarterly)

Perform the following tests quarterly 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	

3.3.4.2 Hot Water Quality Assurance Testing

- a. Complete quarterly testing of Low and Medium Temperature Systems and record the following parameters.

pH	_____
Nitrite or Molybdate	_____ ppm (mg/L)
Iron (total, as Fe(2)O(3))	_____ ppm (mg/L)

Written evaluation summary	
----------------------------	--

- b. Have an independent consultant analyze the hot water once a month for a period of 1 year. Include the following information recorded in accordance with [ASTM D596](#) in the monthly report.

pH	_____
Sulfite (Na ₂ SO ₃)	_____ ppm (mg/L)
Hardness(as CaCO ₃)	_____ ppm (mg/L)
Iron (total, as Fe ₂ O ₃)	_____ ppm (mg/L)
Written evaluation summary	

3.3.5 Corrosion Testers

Install corrosion coupon and rack systems to verify corrosion control in the systems. Install testers or coupons in flowing system water through a sidestream or rack system. Test both mild steel and copper metal samples in the corrosion testers in accordance with [ASTM D2688](#). Replace and analyze samples every 3 months. Rates of corrosion less than 3 mpy for steel and 0.2 mpy for copper are acceptable. Install corrosion testers on the piping systems of the following systems.

Chilled water system
Hot water loop

3.4 CLOSEOUT ACTIVITIES

3.4.1 [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. Conduct the training to include a total of 8 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. Include within the condensed operation instructions all preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. Frame the posted instructions under glass or laminated plastic and post where indicated by the Contracting Officer. Ensure the field instructions cover all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 30 00

HVAC AIR DISTRIBUTION
05/20, CHG 1: 02/22

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

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

- AHRI 260 I-P (2012) Sound Rating of Ducted Air Moving and Conditioning Equipment
- AHRI 350 (2015) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
- AHRI 410 (2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils
- AHRI 430 (2009) Central-Station Air-Handling Units
- AHRI 440 (2008) Performance Rating of Room Fan-Coils
- AHRI Guideline D (1996) Application and Installation of Central Station Air-Handling Units

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

- ABMA 9 (2015) Load Ratings and Fatigue Life for Ball Bearings
- ABMA 11 (2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

- ASHRAE 52.2 (2017) Method of Testing General

Ventilation Air-Cleaning Devices for
Removal Efficiency by Particle Size

ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality
ASHRAE 68	(1997) Laboratory Method of Testing to Determine the Sound Power In a Duct
ASHRAE 70	(2006; R 2021) Method of Testing the Performance of Air Outlets and Inlets
ASHRAE 84	(2020; Errata 2021) Method of Testing Air-to-Air Heat/Energy Exchangers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2020) Scheme for the Identification of Piping Systems
------------	--

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) 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	(2022a) 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 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 C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
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 ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

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

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 1819 (2002) Fire, Smoke and Radiation Damper
Installation Guide for HVAC Systems, 5th
Edition

SMACNA 1966 (2020) HVAC Duct Construction Standards
Metal and Flexible, 4th Edition

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168 (2017) Adhesive and Sealant Applications

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 181 (2013; Reprint Apr 2017) UL Standard for
Safety Factory-Made Air Ducts and Air

Connectors

UL 555	(2006; Reprint Aug 2016) UL Standard for Safety Fire Dampers
UL 586	(2009; Reprint Dec 2017) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 705	(2017; Reprint Aug 2021) UL Standard for Safety Power Ventilators
UL 900	(2015) Standard for Air Filter Units
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
UL Fire Resistance	(2014) Fire Resistance 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
Dedicated Outside Air System	DOAS - ____
Exhaust Fan Number	EF - ____
Fan Coil Unit Number	FCU - ____

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:

- Each point of entry and exit of pipe passing through walls.
- Each change in direction, i.e., elbows, tees.
- In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.
- 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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

SD-03 Product Data

Insulated Nonmetallic Flexible Duct Runouts

Duct Connectors

Duct Access Doors; G

Fire Dampers

Manual Balancing Dampers; G

Diffusers

Registers and Grilles

Louvers

Centrifugal Fans

Panel Type Power Wall Ventilators

Air Handling Units; G

Room Fan-Coil Units; G

Energy Recovery Devices; G

Test Procedures

Diagrams; G

Indoor Air Quality for Duct Sealants;

SD-06 Test Reports

Performance Tests;

Damper Acceptance Test; G

SD-07 Certificates

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

Fire Dampers; G

Manual Balancing Dampers; G

Centrifugal Fans; G

Panel Type Power Wall Ventilators; G

Air Handling Units; G

Room Fan-Coil Units; G

Energy Recovery Devices; G

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.
- d. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or ENERGY STAR covered product categories, equipment selected must have as a minimum the efficiency rating identified under "Energy-Efficient Products" at <http://femp.energy.gov/procurement>.

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 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

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

Except for the fabricated duct, plenums and casings specified in paragraphs "Metal Ductwork" and "Plenums and Casings for Field-Fabricated Units", provide components and equipment that are standard products of manufacturers regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. This requirement applies to all equipment, including diffusers, registers, fire dampers, and balancing dampers.

- a. Standard products are defined as components and equipment that have been in satisfactory commercial or industrial use in similar applications of similar size for at least two years before bid opening.
- b. Prior to this two year period, these standard products must have been sold on the commercial market using advertisements in manufacturers'

catalogs or brochures. These manufacturers' catalogs, or brochures must have been copyrighted documents or have been identified with a manufacturer's document number.

- c. 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.

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 00 INTERIOR 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.
- 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. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.
- 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. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

- 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. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque 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. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.
- e. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors.

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 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. Paint in accordance with Section 09 90 00 PAINTS AND COATINGS.

2.7 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.8 DUCT SYSTEMS

2.8.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification .

- a. Construct ductwork meeting the requirements for the duct system static pressure specified in APPENDIX D of Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.
- 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.
- d. 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.

- f. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not acceptable.
- g. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

2.8.1.1 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.

2.8.1.2 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.

2.8.2 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.

2.8.3 Fire Dampers

Use 1.5 hour rated fire dampers unless otherwise indicated. Provide fire dampers that conform to the requirements of NFPA 90A and UL 555. Perform the fire damper test as outlined in NFPA 90A. Provide a pressure relief door upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then provide a factory installed pressure relief damper. Provide automatic operating fire dampers with a dynamic rating suitable for the maximum air velocity and pressure differential to which it is subjected. Provide fire dampers approved for the specific application, and install according to their listing. Equip fire dampers with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, does not impair the operation of the damper. Equip sleeves or frames with perimeter mounting angles attached on both sides of the wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies in conformance with UL Fire Resistance. Provide curtain type with damper blades out of the air stream fire dampers. Install dampers that do not reduce the duct or the air transfer opening cross-sectional area. Install dampers so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, comply with the installation details given in SMACNA 1819 and in manufacturer's instructions for fire dampers. Perform acceptance testing of fire dampers according to paragraph Fire Damper Acceptance Test and NFPA 90A.

2.8.4 Manual Balancing Dampers

- a. 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.
- b. 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 access doors or panels in hard ceilings, partitions and walls for access to all concealed damper operators and damper locking setscrews. Coordinate location of doors or panels with other affected contractors.
- c. 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.

2.8.4.1 Square or Rectangular Dampers

2.8.4.1.1 Duct Height 12 inches and Less

2.8.4.1.1.1 Frames

Width	Height	Galvanized Steel Thickness	Length
Maximum 19 inches	Maximum 12 inches	Minimum 20 gauge	Minimum 3 inches
More than 19 inches	Maximum 12 inches	Minimum 20 gauge	Minimum 3 inches

2.8.4.1.1.2 Single Leaf Blades

Width	Height	Galvanized Steel Thickness	Length
Maximum 19 inches	Maximum 12 inches	Minimum 20 gauge	Minimum 3 inches
More than 19 inches	Maximum 12 inches	Minimum 20 gauge	Minimum 3 inches

2.8.4.1.1.3 Blade Axles

To support the blades of round dampers, provide galvanized steel shafts supporting the blade the entire duct diameter frame-to-frame. Provide axle shafts that extend through standoff bracket and hand quadrant.

Width	Height	Material	Square Shaft
Maximum 19 inches	Maximum 12 inches	Galvanized Steel	Minimum 3/8 inch
More than 19 inches	Maximum 12 inches	Galvanized Steel	Minimum 1/2 inch

2.8.4.1.1.4 Axle Bearings

Support the shaft on each end at the frames with shaft bearings. Press fit shaft bearings configuration to provide a tight joint between blade shaft and damper frame.

Width	Height	Material
Maximum 19 inches	Maximum 12 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze

Width	Height	Material
More than 19 inches	Maximum 12 inches	oil-impregnated bronze

2.8.4.1.1.5 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Provide a minimum stand-off distance of 2 inches off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.8.4.1.1.6 Finish

Mill Galvanized

2.8.4.1.2 Duct Height Greater than 12 inches

2.8.4.1.2.1 Dampers

Provide dampers with multi-leaf opposed-type blades.

2.8.4.1.2.2 Frames

Maximum 48 inches in height; maximum 48 inches in width; minimum of 20 gauge galvanized steel, minimum of 5 inches long.

2.8.4.1.2.3 Blades

Minimum of 20 gauge galvanized steel; 6 inch nominal width.

2.8.4.1.2.4 Blade Axles

To support the blades of round dampers, provide galvanized square steel shafts supporting the blade the entire duct diameter frame-to-frame. Provide axle shafts that extend through standoff bracket and hand quadrant.

2.8.4.1.2.5 Axle Bearings

Support the shaft on each end at the frames with shaft bearings constructed of oil-impregnated bronze, or solid nylon, or a solid plastic equivalent to nylon. Press fit shaft bearings configuration to provide a tight joint between blade shaft and damper frame.

2.8.4.1.2.6 Blade Actuator

Minimum 1/2 inch diameter galvanized steel.

2.8.4.1.2.7 Blade Actuator Linkage

Mill Galvanized steel bar and crank plate with stainless steel pivots.

2.8.4.1.2.8 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Provide a minimum stand-off distance of 2 inches off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.8.4.1.2.9 Finish

Mill Galvanized

2.8.4.2 Round Dampers

2.8.4.2.1 Frames

Size	Galvanized Steel Thickness	Length
4 to 20 inches	Minimum 24 gauge	Minimum 6 inches
22 to 30 inches	Minimum 22 gauge	Minimum 6 inches
32 to 40 inches	Minimum 20 gauge	Minimum 6 inches

2.8.4.2.2 Blades

Size	Galvanized Steel Thickness
4 to 20 inches	Minimum 24 gauge
22 to 30 inches	Minimum 20 gauge
32 to 40 inches	Minimum 16 gauge

2.8.4.2.3 Blade Axles

To support the blades of round dampers, provide galvanized steel shafts supporting the blade the entire duct diameter frame-to-frame. Provide axle shafts that extend through standoff bracket and hand quadrant.

Size	Shaft Size and Shape
4 to 20 inches	Minimum 3/8 inch square

Size	Shaft Size and Shape
22 to 30 inches	Minimum 1/2 inch square
32 to 40 inches	Minimum 3/4 inch square

2.8.4.2.4 Axle Bearings

Support the shaft on each end at the frames with shaft bearings constructed of oil-impregnated bronze, nylon, or a solid plastic equivalent to nylon. Axle bearings intended for low leakage at the damper frame must be neoprene, nitrile, or equivalent of 60 or greater durometer to reduce damper blade vibration. Press fit shaft bearings configuration to provide a tight joint between blade shaft and damper frame.

Size	Material
4 to 20 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
22 to 30 inches	solid nylon, or equivalent solid plastic, or oil-impregnated bronze
32 to 40 inches	oil-impregnated bronze, or stainless steel sleeve bearing

2.8.4.2.5 Control Shaft/Hand Quadrant

Provide dampers with accessible locking-type control shaft/hand quadrant operators.

Provide stand-off mounting brackets, bases, or adapters for the locking-type quadrant operators on dampers installed on ducts to be thermally insulated. Provide a minimum stand-off distance of 2 inches off the metal duct surface. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.8.4.2.6 Finish

Mill Galvanized

2.8.5 Automatic Balancing Dampers

Provide dampers as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

2.8.6 Diffusers, Registers, and Grilles

Provide factory-fabricated units of 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. 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.

2.8.6.1 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.

2.8.6.2 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.

2.8.7 Louvers

Provide louvers for installation in exterior walls that are associated with the air supply and distribution system as specified in Section 08 91 00 METAL WALL LOUVERS.

2.8.8 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.

2.9 AIR SYSTEMS EQUIPMENT

2.9.1 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 140 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.

2.9.1.1 Centrifugal Fans

Provide fully enclosed, single-width single-inlet, or double-width double-inlet centrifugal fans, with AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Provide impeller wheels that are rigidly constructed and accurately balanced both statically and dynamically. Provide forward curved or backward-inclined airfoil design fan blades in wheel sizes up to 30 inches. Provide backward-inclined airfoil design fan blades for wheels over 30 inches in diameter. Provide fan wheels over 36 inches in diameter with overhung pulleys and a bearing on each side of the wheel. Provide fan wheels 36 inches or less in diameter that have one or more extra long bearings between the fan wheel and the drive. Provide sleeve type, self-aligning and self-oiling bearings with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Connect grease fittings to tubing for serviceability from a single accessible point. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide steel, accurately finished fan shafts, with key seats and keys for impeller hubs and fan pulleys. Provide fan outlets of ample proportions, designed for the attachment of angles and bolts for attaching flexible connections. Provide Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have open dripproof enclosures. Provide across-the-line type motor starters with general-purpose enclosure.

2.9.1.2 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 gravity backdraft dampers where indicated.

2.9.2 Coils

Provide fin-and-tube type coils constructed of seamless copper tubes and aluminum fins mechanically bonded or soldered to the tubes. Provide copper tube wall thickness that is a minimum of 0.020 inches.. Provide aluminum fins that are 0.0075 inch minimum thickness. Provide casing and tube support sheets that are not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. Mount coils for counterflow service. Rate and certify coils to meet the requirements of AHRI 410. Provide factory applied phenolic, vinyl or epoxy/electrodeposition coating.

2.9.2.1 Water Coils

Install water coils with a pitch of not less than 1/8 inch/foot of the tube length toward the drain end. Use headers constructed of cast iron, welded steel or copper. Furnish each coil with a plugged vent and drain connection extending through the unit casing. Provide removable water coils with drain pans. Pressure test coils in accordance with UL 1995.

2.9.2.2 Corrosion Protection for Coastal Installations

Coils in Air Handling Units / DOAS units shall have a 6000 hour salt spray resistant coating in conformance with ASTM B117.

2.9.3 Air Filters

List air filters according to requirements of UL 900, except list high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method under the Label Service to meet the requirements of UL 586.

2.9.3.1 Extended Surface Pleated Panel Filters

Provide 2 inch depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested according to ASHRAE 52.2. Provide initial resistance at 500 fpm that does not exceed 0.36 inches water gauge. Provide UL Class 2 filters, and nonwoven cotton and synthetic fiber mat media. Attach a wire support grid bonded to the media to a moisture resistant fiberboard frame. Bond all four edges of the filter media to the inside of the frame to prevent air bypass and increase rigidity.

2.9.3.2 Holding Frames

Fabricate frames from not lighter than 16 gauge sheet steel with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

2.9.3.3 Filter Gauges

Provide dial type filter gauges, diaphragm actuated draft for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Provide gauges that are at least 3-7/8 inches in diameter, with white dials with black figures, and graduations with a minimum range of 1 inch of water beyond the specified final resistance for the filter bank on which each gauge is applied. Provide each gauge with a screw operated zero adjustment and two static pressure taps with integral compression fittings, two molded plastic vent valves, two 5 foot minimum lengths of 1/4 inch diameter vinyl tubing, and

all hardware and accessories for gauge mounting.

2.10 AIR HANDLING UNITS

2.10.1 Factory-Fabricated Air Handling Units / DOAS Units

Provide single-zone draw-through type units as indicated. Units must include fans, coils, airtight insulated casing, prefilters, secondary filter sections, adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, mixing box combination sectional filter-mixing box, vibration-isolators, total energy desiccant heat wheel and appurtenances required for specified operation. Provide vibration isolators as indicated. Physical dimensions of each air handling unit must be suitable to fit space allotted to the unit with the capacity indicated. Provide air handling unit that is rated in accordance with AHRI 430 and AHRI certified for cooling.

2.10.1.1 Casings

Provide the following:

- a. Casing sections 2 inch double wall type , constructed of a minimum 18 gauge galvanized steel, or 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304. Inner casing of double-wall units that are a minimum 20 gauge solid galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304. Design and construct casing with an integral insulated structural galvanized steel frame such that exterior panels are non-load bearing.
- b. Individually removable exterior panels with standard tools. Removal must not affect the structural integrity of the unit. Furnish casings with access sections, according to paragraph AIR HANDLING UNITS, inspection doors, and access doors, all capable of opening a minimum of 90 degrees, as indicated.
- c. Insulated, fully gasketed, double-wall type inspection and access doors, of a minimum 18 gauge outer and 20 gauge inner panels made of either galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304. Provide rigid doors with heavy duty hinges and latches. Inspection doors must be a minimum 12 inches wide by 12 inches high. Access doors must be a minimum 24 inches wide, the full height of the unit casing or a minimum of 6 foot, whichever is less.
- d. Double-wall insulated type drain pan (thickness equal to exterior casing) constructed of 16 gauge galvanized steel , conforming to ASHRAE 62.1. Construct drain pans water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils must not flow across the face of lower coils. Provide intermediate drain pans or condensate collection channels and downspouts, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Construct drain pan to allow for easy visual inspection, including underneath the coil without removal of the coil and to allow complete and easy physical cleaning of the pan underneath the coil without removal of the coil. Provide coils that are individually removable from the casing.
- e. Casing insulation that conforms to NFPA 90A. Insulate single-wall

casing sections handling conditioned air with not less than 1 inch thick, 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.23 Btu/hr-sf-F. Insulate double-wall casing sections handling conditioned air with not less than 2 inches of the same insulation specified for single-wall casings. Foil-faced insulation is not an acceptable substitute for use with double wall casing. Seal double wall insulation completely by inner and outer panels.

- f. Factory applied fibrous glass insulation that conforms to ASTM C1071, except that the minimum thickness and density requirements do not apply, and that meets the requirements of NFPA 90A. Make air handling unit casing insulation uniform over the entire casing. Foil-faced insulation is not an acceptable substitute for use on double-wall access doors and inspections doors and casing sections.
- g. A latched and hinged inspection door, in the fan and coil sections. Plus additional inspection doors, access doors and access sections where indicated.

2.10.1.2 Heating and Cooling Coils

Provide coils as specified in paragraph AIR SYSTEMS EQUIPMENT.

2.10.1.3 Air Filters

Provide air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.10.1.4 Fans

Provide the following:

- a. Fans that are double-inlet, centrifugal type with each fan in a separate scroll. Dynamically balance fans and shafts prior to installation into air handling unit, then after it has been installed in the air handling unit, statically and dynamically balance the entire fan assembly. Mount fans on steel shafts, accurately ground and finished.
- b. Fan bearings that are sealed against dust and dirt and are precision self-aligning ball or roller type, with L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide bearings that are permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Support bearings by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Do not fasten bearings directly to the unit sheet metal casing. Furnish fans and scrolls with coating indicated.
- c. Fans that are driven by a unit-mounted, or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Furnish belt guards that are the three-sided enclosed type with solid or expanded metal face. Design belt drives for not less than a 1.3 service factor based on motor nameplate rating.
- d. Motor sheaves that are variable pitch for 25 hp and below and fixed pitch above 25 hp as defined by AHRI Guideline D. Where fixed sheaves

are required, the use of variable pitch sheaves is allowed during air balance, but replace them with an appropriate fixed sheave after air balance is completed. Select variable pitch sheaves to drive the fan at a speed that produces the specified capacity when set at the approximate midpoint of the sheave adjustment. Furnish motors for V-belt drives with adjustable bases, and with open enclosures.

- e. Motor starters of across-the-line type with general-purpose enclosure. Select unit fan or fans to produce the required capacity at the fan static pressure with sound power level as indicated. Obtain the sound power level values according to [AMCA 300](#), [ASHRAE 68](#), or [AHRI 260 I-P](#).

2.10.1.5 Access Sections and Filter/Mixing Boxes

Provide access sections where indicated and furnish with access doors as shown. Construct access sections and filter/mixing boxes in a manner identical to the remainder of the unit casing and equip with access doors. Design mixing boxes to minimize air stratification and to promote thorough mixing of the air streams.

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, air filter, fans, motor, fan drive, motor switch, an enclosure for cabinet models and casing for concealed models, and sound power levels as indicated. Obtain sound power level data or values for these units according to test procedures based on [AHRI 350](#). 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 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. Provide duct discharge collar for concealed models.

2.11.1.2 Fans

Provide steel or aluminum, multiblade, centrifugal type fans. 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 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. 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 metal auxiliary drain pans to catch drips from control and piping 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 Filters

Provide disposable type filter that complies with ASHRAE 52.2. Provide filters in each unit that are removable without the use of tools.

2.11.1.6 Motors

Provide motors of the permanent split-capacitor type with built-in thermal overload protection, directly connected to unit fans. Provide ECM motor. 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
300	100	110	110
400	170	150	150
600	180	210	220
800	240	240	230

Free Discharge Motors			
Unit Capacity (cfm)	Maximum Power Consumption (Watts)		
	115V	230V	277V
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 Rotary Wheel

Provide unit that is a factory fabricated and tested assembly for air-to-air energy recovery by transfer of sensible heat from exhaust air to supply air stream, with device performance according to ASHRAE 84 and that delivers an energy transfer effectiveness of not less than 70 percent with cross-contamination not in excess of 1.0 percent of exhaust airflow rate at system design differential pressure, including purging sector if provided with wheel. Provide exchange media that is chemically inert, moisture-resistant, fire-retardant, laminated, nonmetallic material which complies with NFPA 90A. Isolate exhaust and supply streams by seals which are static, field adjustable, and replaceable. Equip chain drive mechanisms with ratcheting torque limiter or slip-clutch protective device. Fabricate enclosure from galvanized steel and include provisions for maintenance access. Provide recovery control and rotation failure provisions as indicated.

2.12.2 Desiccant Wheel

Provide counterflow supply, regeneration airstreams, a rotary type dehumidifier designed for continuous operation, and extended surface type wheel structure in the axial flow direction with a geometry that allows

for laminar flow over the operating range for minimum air pressure differentials. Provide the dehumidifier complete with a drive system utilizing a fractional-horsepower electric motor and speed reducer assembly driving the rotor. Include a slack-side tensioner for automatic take-up for belt-driven wheels. Provide an adsorbing type desiccant material. Apply the desiccant material to the wheel such that the entire surface is active as a desiccant and the desiccant material does not degrade or detach from the surface of the wheel which is fitted with full-face, low-friction contact seals on both sides to prevent cross leakage. Provide rotary structure that has underheat, overheat and rotation fault circuitry. Provide wheel assembly with a warranty for a minimum of five years.

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.

2.14 SUPPLEMENTAL COMPONENTS/SERVICES

2.14.1 Chilled Water Piping

The requirements for chilled, condenser, or dual service water piping and accessories are specified in Section [23 64 26](#) CHILLED WATER PIPING SYSTEMS

2.14.2 Water or Steam Heating System Accessories

The requirements for water or steam heating accessories such as expansion tanks and steam traps are specified in Section [23 21 13.00 20](#) LOW TEMPERATURE WATER (LTW) HEATING SYSTEM.

2.14.3 Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that generates condensate in accordance with Section [23 64 26](#) CHILLED WATER PIPING SYSTEMS except as modified herein.

2.14.4 Backflow Preventers

The requirements for backflow preventers are specified in Section [22 00 00](#) PLUMBING, GENERAL PURPOSE.

2.14.5 Insulation

The requirements for shop and field applied insulation are specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.14.6 Controls

The requirements for controls are specified in Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

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. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of 3 feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices) and an additional 3 feet.
- 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

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the

surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.3 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced.

3.2.4 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.

3.2.5 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.

3.2.6 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 and plenums .

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.

3.2.9 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.3 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum **3-inch** margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of 14 calendar days before being loaded.

3.4 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.

3.5 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. When the work area is in an occupied space such as office, laboratory or warehouse protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 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.

3.6.1 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.

3.6.2 Framed Prepared Openings

Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

3.6.3 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.

3.6.4 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.

3.6.5 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.

3.7 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.

3.7.1 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.

3.7.2 Temperatures between 120 and 400 degrees F

Apply two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of two mils to metal surfaces subject to temperatures between 120 and 400 degrees F.

3.7.3 Temperatures greater than 400 degrees F

Apply two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of two mils to metal surfaces subject to temperatures greater than 400 degrees F.

3.8 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.

3.9 DUCTWORK LEAK TESTS

The requirements for ductwork leak tests are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.

3.10 DAMPER ACCEPTANCE TEST

Submit the proposed schedule, at least 2 weeks prior to the start of test. Operate all fire dampers and smoke dampers under normal operating conditions, prior to the occupancy of a building to determine that they function properly. Test each fire damper equipped with fusible link by having the fusible link cut in place. Test dynamic fire dampers with the air handling and distribution system running. Reset all fire dampers with the fusible links replaced after acceptance testing. To ensure optimum operation and performance, install the damper so it is square and free from racking.

3.11 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.

3.12 PERFORMANCE TESTS

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.

3.13 CLEANING AND ADJUSTING

Provide a temporary bypass for water coils to prevent flushing water from passing through coils. Inside of room fan-coil units 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.

3.14 OPERATION AND MAINTENANCE

3.14.1 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

3.14.2 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 8 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 52 43.00 20

LOW PRESSURE WATER HEATING BOILERS (UNDER 800,000 BTU/HR OUTPUT)
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 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 MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IV (2017) BPVC Section IV-Rules for
Construction of Heating Boilers

ASME CSD-1 (2016) Control and Safety Devices for
Automatically Fired Boilers

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M (2022) Standard Specification for Pipe,
Steel, Black and Hot-Dipped, Zinc-Coated,
Welded and Seamless

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBI)

NBBI NB-23 PART 1 (2013) National Board Inspection Code -
Part 1 Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (2018) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31 (2020) Standard for the Installation of
Oil-Burning Equipment

NFPA 54 (2021) National Fuel Gas Code

NFPA 70 (2023) National Electrical Code

NFPA 211 (2019) Standard for Chimneys, Fireplaces,
Vents, and Solid Fuel-Burning Appliances

UNDERWRITERS LABORATORIES (UL)

UL 795 (2016) UL Standard for Safety
Commercial-Industrial Gas Heating Equipment

UL 1738

(2010; Reprint Feb 2020) Venting Systems
for Gas-Burning Appliances, Categories II,
III and IV

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein.

1.3 DESIGN REQUIREMENTS

Boiler must be suitable for installation in the space shown with ample room for opening doors and cleaning and removal and replacement of tubes. Boiler must be designed and tested in accordance with ASME BPVC SEC IV, ASME CSD-1, NFPA 54, NFPA 31, NFPA 70 and ANSI Z21.13/CSA 4.9. Boiler must be installed in accordance with NBBI NB-23 PART 1. Paint boiler in accordance with manufacturer's recommendations. Provide a thermostatically controlled three-way mixing valve on boiler suitable for operating conditions of the boiler.

1.3.1 Boiler Installation Requirements

1.3.1.1 Location

Install Boiler(s) and associated hot water pumps in a mechanical room inside the facility in accordance with NBBI NB-23 PART 1. Provide ample clearance around boilers to allow access for inspection, maintenance and repair. Passageways around all sides of boilers must have an unobstructed minimum width of 36 inches or the clearances recommended by the boiler manufacturer whichever is greater.

1.3.1.2 Combustion Air

Provide supply of air for combustion and ventilation. In accordance with NFPA 54, NFPA 211 and manufacturer's installation manual, calculate the amount of combustion air necessary to operate the boiler. Install and locate properly sized combustion air dampers and louvers.

1.3.1.3 Sequence of Operation

Local, manual starting of boilers is required. Remote starting and stopping of the boiler by the HVAC control system is not permitted. This is to ensure that an operator witness the initial firing of the boiler at the beginning of each heating season to verify proper operation of the boiler and to promote proper maintenance.

1.3.2 Detail Drawings

1.3.2.1 Drawings

Show boiler hot water isolation valves, emergency disconnect switch, and complete boiler gas train on the contract drawings.

1.3.2.2 Fuel Train / Wiring Diagram

Submit fuel train and wiring diagram.

1.4 SAFETY STANDARDS

Hot water boilers, burners and supplementary control devices, safety interlocks, or limit controls required under this specification, must meet requirements of the following standards as applicable:

- a. Gas-Fired Units: ASME CSD-1, NFPA 54, NFPA 70, ANSI Z21.13/CSA 4.9 or UL 795.
- b. All Units: ASME BPVC SEC IV, NFPA 70 and ASME CSD-1.

Controls not covered by the above must have a UL label, UL listing mark, or must be listed in the Factory Mutual Approval Guide.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submittals for this Section must be delivered to the project Contracting Officer, who will forward two complete sets of copies to the appropriate approving official for review and approval.

SD-02 Shop Drawings

Fuel Train

Wiring Diagram

SD-03 Product Data

Boilers

Boiler Trim and Control Equipment

Stack, Breeching, and Supports

SD-06 Test Reports

Operational Tests

SD-07 Certificates

Boilers

Boiler Trim and Control Equipment

Boiler manufacturer's certificate of boiler performance including evidence that the burners provided must be a make, model, and type certified and approved by the manufacturer of the boiler being provided.

SD-08 Manufacturer's Instructions

Boilers

SD-10 Operation and Maintenance Data

Boilers, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted Operating Instructions for Heating Water Boilers

PART 2 PRODUCTS

2.1 BOILERS

Provide a natural gas-fired full condensing boiler complete with firing equipment, combustion chamber, insulation with steel jacket, safety and operating controls, integral electrical wiring and other appurtenances, to make the boiler a complete, self-contained, fully-automatic unit, ready for service upon completion of utility connections. Gas fired boilers greater than 300,000 Btuh input must have a thermal efficiency of at least 90 percent when fired at the maximum and minimum capacities which are provided and allowed by the controls.

2.1.1 General Requirements

Design, construction, installation, testing, and operation of boiler and appurtenances shall comply with NBBI NB-23 PART 1, ASME BPVC SEC IV, ASME CSD-1, NFPA 54, NFPA 31, ANSI Z21.13/CSA 4.9, and the manufacturer's instructions.

2.1.2 Features

Provide a commercial, full condensing type boiler, with a combustion system consisting of gas valve and combustion blower designed to work in concert and have sealed combustion chamber. The boiler must be capable of a 5:1 turndown ratio to provide maximum system flexibility. Provide direct spark ignition. The boiler must be capable of low gas pressure operation and low NOx operation.

2.1.3 Construction

Construct the boiler with a heavy gauge steel outer jacket assembly, primed, and pre-painted on both sides. The outer jacket assembly must be completely independent of the combustion chamber.

2.1.4 Heat Exchanger

Construct the heat exchanger(s) of 316L stainless steel and be designed for a 160 psi working pressure in accordance with ASME BPVC SEC IV and bear the ASME "H" stamp. The heat exchanger shall be of gasketless design and shall be designed to drain condensation from the heat exchanger assembly. Provide a burner/flame observation port.

2.1.5 Controls

Provide each hot water heating boiler with a digital operating control system with multi-color graphic LCD display and include a BACnet control interface to allow the boiler to be connected to the building DDC system as specified in specification section 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC. Provide a control system that includes, as a minimum, the following features:

- a. Sequencer for controlling the boilers for "Lead Lag" and "Efficiency Optimization".
- b. System pump control for controlling a variable speed boiler pump to keep a constant delta T at all modulation rates.

Condensate Nutralization Tank

Provide a separate condensate nutralization tank including all necessary chemicals. Route the boiler condensate drain line into a factory provided plastic trap and then to the inlet of this tank. Route the outlet of the tank to the nearest floor drain.

2.2 BOILER TRIM AND CONTROL EQUIPMENT

2.2.1 Emergency Disconnect Switch

Provide and locate on wall outside boiler room entrance or just inside door, when boiler room door is on building exterior as required by ASME CSD-1 to allow rapid and complete shutdown of the boiler in the event of an emergency. Emergency switch must be a pushbutton type safety switch. Switch must be red and furnished with a label indicating function of switch.

2.2.2 Relief Valves

Provide relieving capacity for the full output of boiler installed. Safety relief-valve piping must conform to ASTM A53/A53M, schedule 40 steel pipe and be piped full-size to a floor drain .

2.2.3 Pressure and Altitude Gage or Combination Pressure/Altitude Gage

Provide one located on supply water piping and one on return water piping.

2.2.4 Thermometer

Provide thermometer with a scale equivalent to 1.5 times outlet water temperature. Provide one located on supply water piping and one on return water piping.

2.2.5 Drain Tapping

Provide drain valve and piping to a floor drain .

2.2.6 Make-up Water Station

2.2.6.1 Pressure Reducing Station

Provide a water pressure-reducing valve and relief valve, or a combination of the two in the makeup water line to the boiler to maintain a water

pressure of 12 psig in the hot water system. Provide a 3/4 inch globe valve by-pass around this valve.

2.2.7 Combustion Regulator

Provide adjustable temperature, thermostatic immersion type that must limit boiler water temperature to a maximum of 250 degrees F. Control must actuate burner through an electric relay system to maintain boiler water temperature within normal prescribed limits at loads within rated capacity of boiler.

2.2.8 Air Vent Valve

Provide with screwed connection, stainless steel disk, and stainless steel seats to vent entrapped air.

2.2.9 High Temperature Limit Switch

Provide adjustable immersible aquastat type with a temperature setting above that of the combustion regulator and below that of the lowest relief valve setting. Aquastat must function to cause a safety shutdown by closing fuel valves and shutting down burner equipment , activating a red indicating light, and sounding an alarm in the event that boiler water temperature rises to the high temperature limit setting. A safety shutdown due to high temperature must require manual reset before operation can resume and prevent recycling of burner equipment. Pre-set high temperature limit devices that cannot be easily tested are not allowed.

2.2.10 Low Water Level Cutoff Switch

Low water level cutoff must cause a safety shutdown by closing fuel valves and shutting down burner equipment , activating a red indicating light, and sounding an alarm in the event that water level drops below the lowest safe permissible water level established by the boiler manufacturer and ASME BPVC SEC IV. A safety shutdown due to low water must require manual reset before operation can resume and prevent recycling of burner equipment.

2.2.11 Boiler Safety Control Circuits

Provide boiler safety control circuits, including control circuits for burner and draft fan, must be single-phase, two-wire one-side grounded, and not over 120 volts. Provide safety control switching in ungrounded conductors. Provide overcurrent protection. In addition to circuit grounds, ground metal parts which do not carry current to a grounding conductor.

2.2.12 Indicating Lights

Each safety interlock requiring a manual reset must have an individually labeled red indicating light. Non-recycling control interlocks must have the reset located on the control itself. Red indicating lights on the control panel may be omitted if the burner combustion control system has a Keyboard Display Module installed that will identify the lockout information required in Item c. below. Indicating lights must have colors as follows:

- a. Amber: Ignition on

- b. Green: Main fuel safety shut-off valves open
- c. Red (One for Each): Safety lockout, flame failure, low water level, and high temperature
- d. Blue: Draft

2.2.13 Alarm Bell

Provide alarm bell, electrically operated, with a manual disconnect switch. Disconnect switch must be type and wired so that switching off alarm following a safety shutdown will not prevent alarm from sounding again upon recurrence of a subsequent safety shutdown condition.

2.2.14 Post-Combustion Purge

Provide controls and wiring necessary to ensure operation of draft fan for a period of not less than 15 seconds or of sufficient duration to provide four complete air changes in the boiler combustion chamber (whichever is greater) following shutdown of burner upon satisfaction of heat demand and in accordance with ASME CSD-1 . Upon completion of post-combustion purge period, draft fan must automatically shutdown until next restart.

2.2.15 Draft

Comply with boiler manufacturer's recommendations.

2.2.16 Stack, Breeching, and Supports

Direct vent sidewall system with a horizontal sidewall termination of both the vent and combustion air. The flue shall be UL 1738, stainless steel, prefabricated multi-wall type, sealed vent material, terminating at the sidewall with the manufacturer's specified vent termination. The air inlet pipe shall be stainless steel sealed pipe. The air inlet must terminate on the same sidewall with the manufacturer's specified air inlet cap. The total combined length of the combined exhaust venting length shall not exceed 100 equivalent feet. The total combined length of the combined air intake length shall not exceed 100 equivalent feet.

2.3 ELECTRIC MOTORS

Electric motors must meet requirements of NEMA MG 1. Motors less than 1 hp must meet NEMA High Efficiency requirements. Motors 1 hp and larger must meet NEMA Premium Efficiency requirements. Motors which are an integral part of the packaged boiler system must be the highest efficiency available by the manufacturer of the packaged boiler. Motors must be variable speed.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

Install equipment in accordance with manufacturer's installation instructions and NBBI NB-23 PART 1. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low

pockets. Feedwater treatment feeders must be mounted so that the top of the feeder is no higher than 48 inches above the finished floor.

3.2 EQUIPMENT FOUNDATIONS

Locate equipment foundations as indicated, designed, and made of sufficient size and weight to preclude shifting of equipment under operating conditions or under abnormal conditions that could be imposed upon the equipment. Foundations must meet requirements of the equipment manufacturer.

3.3 FIELD QUALITY CONTROL

Perform and furnish everything required for inspections and tests as specified herein to demonstrate that boiler and auxiliary equipment, as installed, are in compliance with contract requirements. Start-up and operate the system. During this time, clean strainers until no further accumulation of foreign material occurs. Exercise care to minimize loss of water when strainers are cleaned. Adjust safety and automatic control instruments as necessary to place them in proper operation and sequence. Test instrumentation must be calibrated and have full scale readings from 1.5 to 2 times test values.

3.3.1 Operational Tests

Furnish the services of an engineer or technician approved by the boiler manufacturer of installation, startup, operational and safety testing. This person must remain on the job until each boiler has been successfully operated. Furnish and perform everything required for inspections and tests of the boiler and auxiliary equipment. Test instrumentation must be calibrated and have full-scale reading from 1.5 to 2 times test values. Demonstrate proper operability of combustion control, flame safeguard control and safety interlocks. Provide a detailed description of all boiler startup and operational tests in the Commissioning Plan.

3.3.1.1 Preliminary Operational Test

Operate the boilers continuously for a period of at least 8 hours to demonstrate proper operability of the combustion control, flame safeguard control, and safety interlocks.

3.3.1.2 Acceptance Operational Test and Inspection

Prior to requesting an acceptance test, conduct a satisfactory operational test for at least 8 hours, and provide a certified statement that the equipment is installed per all requirements of this guide. Contracting Officer, upon receipt of the notice from the Contractor, will request a boiler inspection by a Naval Facilities Engineering and Expeditionary Warfare Center (EXWC) NAVFAC boiler inspector. Fifteen days advance notice is required for scheduling inspector to conduct acceptance operational test and inspection.

-- End of Section --

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 SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34 (2016) ANSI/ASHRAE Standard 15-Safety
Standard for Refrigeration Systems and
ANSI/ASHRAE Standard 34-Designation and
Safety Classification of Refrigerants

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC VIII D1 (2019) BPVC Section VIII-Rules for
Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1 (2021) Safety in Welding and Cutting and
Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A307 (2021) Standard Specification for Carbon
Steel Bolts, Studs, and Threaded Rod 60
000 PSI Tensile Strength

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

ASTM F104 (2011; R 2020) Standard Classification
System for Nonmetallic Gasket 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 Contractor Quality Control approval. 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

Verification of Dimensions

Factory Tests

System Performance Tests

Demonstrations

Refrigerant

Water Chiller - Field Acceptance Test Plan

SD-06 Test Reports

Field Acceptance Testing

Water Chiller - Field Acceptance Test Report

Factory Tests

System Performance Tests

SD-07 Certificates

Refrigeration System; G

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Water Chiller - Installation Instructions; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

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

Major equipment including chillers, compressors, compressor drivers, condensers, water coolers, receivers, refrigerant leak detectors, heat exchanges, fans, and motors 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.

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. Motor enclosure type may be either TEAO or TEFC.
- e. Use adjustable frequency drives for all variable-speed motor applications. Provide variable frequency drives for motors as specified.
- f. Provide inverter duty premium efficiency motors for use with variable frequency drives.

2.4 SELF-CONTAINED WATER CHILLERS, VAPOR COMPRESSION TYPE

Water chiller: Unless necessary for delivery purposes, units must be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the factory. In lieu of delivery constraints, a chiller may be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site by a factory representative. Unit components delivered separately must be sealed and charged with a nitrogen holding charge. Parts weighing 50

pounds or more which must be removed for inspection, cleaning, or repair, such as motors, gear boxes, cylinder heads, casing tops, condenser, and cooler heads, must have lifting eyes or lugs. Chiller must be provided with a single point wiring connection for incoming power supply. Chiller's condenser and water cooler must be provided with standard water boxes with flanged connections.

2.4.1 Scroll 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 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. Chiller and individual chiller components must be isolated from the building structure by means of molded neoprene isolation pads.

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, power wiring, and control wiring. Controls package must provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and BAS 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 0 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. Entering and leaving chilled water pressure
- c. (blank)
- d. Self diagnostic
- e. Operation status
- f. Operating hours
- g. Number of starts
- h. Compressor status (on or off)
- i. Compressor load (percent)

- j. Refrigerant discharge and suction pressures
- k. Magnetic bearing levitation status (if applicable)
- l. Magnetic bearing temperatures (if applicable)
- m. Oil pressure

2.5.4.3 Configurable Setpoints

The control system must be capable of being configured directly at the unit's interface panel. No parameters may be capable of being changed without first entering a security access code. 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. Magnetic bearing controller (MBC), Internal fault (if applicable)
- h. MBC, High bearing temperature (if applicable)
- i. MBC, Communication fault (if applicable)
- j. MBC, Power supply fault (if applicable)
- k. 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
- c. MBC, Vibration (if applicable)
- d. MBC, No levitation (if applicable)

e. Phase reversal protection

2.5.4.6 Remote Alarm

During the initiation of a safety shutdown, a chiller's control system must be capable of activating a remote alarm bell. In coordination with the chiller, the Contractor must provide an alarm circuit (including transformer if applicable) and a minimum 4 inch diameter alarm bell. Alarm circuit must activate bell in the event of machine shutdown due to the chiller's monitoring of safety controls. The alarm bell must not sound for a chiller that uses low-pressure cutout as an operating control.

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.

2.5.6 Compressor Driver, Electric Motor

Components such as motors, starters, variable speed drives and wiring must be in accordance with paragraph ELECTRICAL WORK. Motor starterVariable frequency drive must be unit mounted as indicated with startervariable frequency drive type, wiring, and accessories coordinated with the chiller manufacturer.

2.5.7 Compressor Driver Connections

Each machine driven through speed-increasing gears must be so designed as to assure self-alignment, interchangeable parts, proper lubrication system, and minimum unbalanced forces. Bearings must be of the sleeve or roller type. Gear cases must be oil tight. Shaft extensions must be provided with seals to retain oil and exclude all dust.

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. Each tube must be individually replaceable. Tubes must be installed into carbon mild steel tube sheets by rolling. Tube baffles must be properly spaced to provide adequate tube support and cross flow. 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.

Brazed plate heat exchanger must be constructed of 304 or 316 stainless steel, designed to a refrigerant-side working pressure of 430 psig and a waterside working pressure of 150 psig. Evaporator must be factory tested

at 1.1 times maximum allowable refrigerant side working pressure and 1.5 times maximum allowable water side working pressure. Provide cooler heaters to protect the evaporator to an ambient of [minus 20 degrees F](#). Provide cooler with factory-installed flow switches. All water connections must use either flanged or grooved-pipe connections. Factory insulate all cold surfaces.

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 tubes with compatible 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](#).

Coil must be entirely coated in accordance with the requirements of paragraph COIL CORROSION PROTECTION.

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.

2.5.11 Chiller Purge System

Chillers which operate at pressures below atmospheric pressure must be provided with a purge system. Purge system must automatically remove air, water vapor, and non-condensable gases from the chiller's refrigerant while keeping refrigerant emissions below requirements of ASHRAE Std 147. Purge units must be certified per AHRI 580. Purge system must condense, separate, and return all refrigerant back to the chiller. An oil separator must be provided with the purge system if required by the manufacturer. Purge system must not discharge to occupied areas, or create a potential hazard to personnel. Purge system must include a purge pressure gauge, number of starts counter, and an elapsed time meter. Purge system must include lights or an alarm which indicate excessive purge or an abnormal air leakage into chiller.

2.6 ACCESSORIES

2.6.1 Refrigerant Relief Valve/Rupture Disc Assembly

The assembly must be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly must be in accordance with [ASME BPVC SEC VIII D1](#) and [ANSI/ASHRAE 15 & 34](#). The assembly must be provided with a pressure gauge assembly which will provide local

indication if a rupture disc is broken. Rupture disc must be the non-fragmenting type.

2.6.2 Refrigerant Signs

Refrigerant signs must be a medium-weight aluminum type with a baked enamel finish. Signs must be suitable for indoor or outdoor service. Signs must have a white background with red letters not less than 0.5 inches in height.

2.6.2.1 Installation Identification

Each new refrigerating system must be provided with a refrigerant sign which indicates the following as a minimum:

- a. Contractor's name.
- b. Refrigerant number and amount of refrigerant.
- c. The lubricant identity and amount.
- d. Field test pressure applied.

2.6.2.2 Controls and Piping Identification

Refrigerant systems containing more than 110 lb of refrigerant must be provided with refrigerant signs which designate the following as a minimum:

- a. Valves or switches for controlling the refrigerant flow and the refrigerant compressor(s).
- b. Pressure limiting device(s).

2.6.3 Gaskets

Gaskets must conform to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.6.4 Bolts and Nuts

Bolts and nuts, except as required for piping applications, must be in accordance with ASTM A307. The bolt head must be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

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 3000 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.

2.7.3 Coil Corrosion Protection

Provide coil with a uniformly applied epoxy electrodeposition phenolic vinyl type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum 3,000 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.8 FACTORY TESTS

2.8.1 Chiller Performance Test

The Contractor and proposed chiller manufacturer shall be responsible for performing the chiller factory test to validate the specified full load capacity, full load EER, and NPLV in accordance with AHRI 550/590 I-P except as indicated. The Contractor and chiller manufacturer must provide to the Government a certified chiller factory test report in accordance with AHRI 550/590 I-P to confirm that the chiller performs as specified. Tests must be conducted in an AHRI certified test facility in conformance with AHRI 550/590 I-P procedures and tolerances, except as indicated. At a minimum, chiller capacity must be validated to meet the scheduled requirements indicated on the drawings. Tolerance or deviation must be in strict accordance with AHRI 550/590 I-P. Stable operation at minimum load of 15 percent of total capacity must be demonstrated during the factory test.

2.8.1.1 Temperature Adjustments

Temperature adjustments must adhere to AHRI 550/590 I-P to adjust from the

design fouling factor to the clean tube condition. Test temperature adjustments must be verified prior to testing by the manufacturer. There must be no exceptions to conducting the test with clean tubes with the temperature adjustments per AHRI 550/590 I-P. The manufacturer must clean the tubes prior to testing to obtain a test fouling factor of 0.0000.

2.8.1.2 Test Instrumentation

The factory test instrumentation must be per AHRI 550/590 I-P and the calibration must be traceable to the National Institute of Standards and Technology.

2.8.1.3 Equipment Adjustments

If the equipment fails to perform within allowable tolerances, the manufacturer must be allowed to make necessary revisions to his equipment and retest as required.

2.9 SUPPLEMENTAL COMPONENTS/SERVICES

2.9.1 Chilled Water Piping and Accessories

Chilled and condenser water piping and accessories must be provided and installed in accordance with Section 23 64 26 CHILLED WATER PIPING SYSTEMS.

2.9.2 Temperature Controls

Chiller control packages must be fully coordinated with and integrated into the temperature control system indicated in Section 23 30 00 HVAC AIR DISTRIBUTION and 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC .

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 Vibration Isolation

If vibration isolation is specified for a unit, vibration isolator literature must be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

3.1.3 Verification of Dimensions

Provide a letter including the date the site was visited, conformation of existing conditions, and any discrepancies found.

3.1.4 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.

3.1.5 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.

3.1.6 Operation and Maintenance Manuals

Provide Six 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. Six 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.

3.1.7 Connections to Existing Systems

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.8 Refrigeration System

3.1.8.1 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, including frames or supports for compressors, pumps, cooling towers, condensers, water coolers, and similar items. Compressors must be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations must be provided. Each foundation must include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment must be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps must have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the combined pump, motor, and base weights. Isolators must be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators must limit vibration to 5 percent at lowest equipment rpm. Lines connected to pumps mounted on pedestal blocks must be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts must be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.1.8.2 Field Refrigerant Charging

- a. Initial Charge: Upon completion of all the refrigerant pipe tests, the vacuum on the system must be broken by adding the required charge of dry refrigerant for which the system is designed, in accordance with the manufacturer's recommendations. Contractor must provide the complete charge of refrigerant in accordance with manufacturer's recommendations. Upon satisfactory completion of the system performance tests, any refrigerant that has been lost from the system must be replaced. After the system is fully operational, service valve seal caps and blanks over gauge points must be installed and tightened.
- b. Refrigerant Leakage: If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must immediately be isolated from the remainder of the system and the refrigerant must be pumped into the system receiver or other suitable container. The refrigerant must not be discharged into the atmosphere.
- c. Contractor's Responsibility: The Contractor must, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time must more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year must be repaired in accordance with the specified requirements including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.1.8.3 Oil Charging

Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase must be furnished. One charge must be used during the performance testing period, and upon the satisfactory completion of the tests, the oil must be drained and replaced with the second charge.

3.1.9 Field Applied Insulation

Field installed insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.1.10 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.2 FACTORY TEST SCHEDULING AND REPORTS

Provide schedules which identify the date, time, and location for each test. Schedules must be submitted for the Chiller Performance Tests. Copies of the certified test report must be forwarded to the Government for approval prior to project acceptance. Calibration curves and information sheets for all instrumentation must be included. Provide copies in bound 8 1/2 by 11 inch booklets. Reports must certify the compliance with performance requirements and follow the format of the required testing standard for the Chiller Performance Tests. Test report must include certified calibration report of all test instrumentation. Calibration report must include certification that all test instrumentation has been calibrated within 6 months prior to the test date, identification of all instrumentation, and certification that all instrumentation complies with requirements of the test standard. Test report must be submitted 1 week after completion of the factory test.

3.3 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative must be provided for 1 days. The representative shall advise on the following:

a. Hermetic machines:

- (1) Testing hermetic water-chilling unit under pressure for refrigerant leaks; evacuation and dehydration of machine to an absolute pressure of not over 300 micrometers.
- (2) Charging the machine with refrigerant.
- (3) Starting the machine.

3.4 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. Perform and document that proper Indoor Air

Quality During Construction procedures have been followed; this includes providing documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. System must be maintained in this clean condition until final acceptance. 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 and split-system water chillers must be cleaned in accordance with the chiller manufacturer's instructions. This work covers two coil cleanings. The condenser coils must be cleaned with an approved coil cleaner by a service technician, factory trained by the chiller manufacturer. The condenser coil cleaner must not have any detrimental affect on the materials or protective coatings on the condenser coils. Testing, adjusting, and balancing must be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.5 FIELD ACCEPTANCE TESTING

3.5.1 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. Coordinated testing: Indicate in each field acceptance test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of tower system controls which interlock and interface with controls for the equipment provided under 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.
 - c. Prerequisite testing: Chillers for which performance testing is dependent upon the completion of the work covered by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC must have that work completed as a prerequisite to testing work under this section. Indicate in each field acceptance test plan when such prerequisite work is required.
 - d. 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.

Controller must be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

- e. 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.

- f. Job specific: Each test plan must be job specific and must address the particular cooling towers and particular conditions which exist in this contract. Generic or general preprinted test procedures are not acceptable.
- g. Specialized components: Each test plan must include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

3.5.2 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.

3.6 SYSTEM PERFORMANCE TESTS

Six copies of the report must be provided in bound 8 1/2 by 11 inch booklets.

3.6.1 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.

3.6.2 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.
- (7) The position of the capacity-reduction gear at machine off, one-third loaded, one-half loaded, two-thirds loaded, and fully loaded.

3.7 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 8 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 64 26

CHILLED WATER PIPING SYSTEMS

08/09, 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.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4 (2015; R 2020) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

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 B31.9 (2020) Building Services Piping

ASME B40.100 (2013) Pressure Gauges and Gauge Attachments

ASME BPVC SEC IX (2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003 (2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M (2019) Specification for Filler Metals for Brazing and Braze Welding

AWS BRH (2007; 5th Ed) Brazing Handbook

AWS D1.1/D1.1M (2020; Errata 1 2021) Structural Welding Code - Steel

AWS Z49.1 (2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) 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 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 B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D596	(2001; R 2018) Standard Guide for Reporting Results of Analysis of Water
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F1007	(2018) Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2019) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications
ASTM F1199	(2021) Standard Specification for Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds (2015) (10th Ed) EJMA Standards

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-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-69 (2003; Notice 2012) Pipe Hangers and
Supports - Selection and Application (ANSI
Approved American National Standard)

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 (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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Calibrated Balancing Valves; G

Water Temperature Regulating Valves; G

Water Pressure Reducing Valve

Pressure Relief Valve

Combination Pressure and Temperature Relief Valves

Expansion Joints; G

Pumps; G

Combination Strainer and Pump Suction Diffuser

Expansion Tanks

Air Separator Tanks

Water Treatment Systems; G

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

Piping Welds NDE Report

Pressure Tests Reports; G

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.

SD-07 Certificates

Employer's Record Documents (For Welding)

Welding Procedures and Qualifications

Certificates shall be submitted showing conformance with the referenced standards contained in this section.

SD-08 Manufacturer's Instructions

Lesson plan for the Instruction Course; G

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.

Water Treatment Systems; G

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. Include testing procedures used in determining water quality.

A maintenance manual in bound 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide.

Calibrated Balancing Valves, Data Package 3; G

Water Temperature Regulating Valves, Data Package 3; G

Water Pressure Reducing Valve, Data Package 3; G

Pressure Relief Valve, Data Package 2; G

Combination Pressure and Temperature Relief Valves, Data Package 2; G

Expansion Joints, Data Package 2; G

Pumps, Data Package 3; G

Combination Strainer and Pump Suction Diffuser, Data Package 2; G

Expansion Tanks, Data Package 2; G

Air Separator Tanks, Data Package 2; G

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 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.

2.2.1 Tube

Use copper tube conforming to ASTM B88, Type L for aboveground tubing, and

Type K for buried tubing.

2.2.2 Fittings and End Connections (Solder and Flared Joints)

Wrought copper and bronze solder joint pressure fittings, including unions and 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](#).

Copper tubing of sizes larger than [4 inches](#) shall have brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

Extracted brazed tee joints may be used if produced with an acceptable tool and installed in accordance with tool manufacturer's written procedures.

2.2.3 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](#).

2.2.4 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.

2.3 VALVES

Provide valves with a ANSI/ASME Class 125 service rating, which for [150 degrees F](#), the pressure rating is [175 psig](#).

Valves in sizes larger than [1 inch](#) and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be furnished by the same manufacturer as the grooved pipe joint and fitting system.

2.3.1 Gate Valve

Gate valves [2-1/2 inches](#) and smaller shall conform to [MSS SP-80](#) Class 125 and shall be bronze with wedge disc, rising stem and threaded, soldered, or flanged ends. Gate valves [3 inches](#) and larger shall conform to [MSS SP-70](#), Class 125, cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.3.2 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.

2.3.3 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.

2.3.4 Butterfly Valve

Butterfly valves shall conform to MSS SP-67, Type 1 and shall be either the wafer or lug type. 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.

2.3.5 Plug Valve

Plug valves 2 inches and larger shall conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 2 inches and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valve shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valve shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valve shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.3.6 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. Ball valves may be provided in lieu of gate valves.

2.3.7 Square Head Cocks

Provide copper alloy or cast-iron body with copper alloy plugs, suitable for 125 psig water working pressure.

2.3.8 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.

2.3.9 Water Temperature Regulating Valves

Provide copper alloy body, direct acting, pilot operated, for the intended

service.

2.3.10 Water Pressure Reducing Valve

Valve, **ASSE 1003** for water service, copper alloy body.

2.3.11 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.

2.3.12 Combination Pressure and Temperature Relief Valves

ANSI Z21.22/CSA 4.4, copper alloy body, automatic re-seating, test lever, and discharge capacity based on AGA temperature steam rating.

2.3.13 Float Valve

Angle pattern and/or Globe pattern. Valve bodies **3 inches** nominal pipe size and smaller shall be bronze. Valve bodies larger than **3 inches** shall be cast iron or bronze. Steel parts shall be corrosion resistant. Where float rods are extended for tank applications, extension shall be properly supported and guided to avoid bending of float rod or stressing of valve pilot linkage.

2.3.14 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. Freeze-proof type valves shall be provided in installations exposed to freezing temperatures.

2.3.15 Air Venting Valves

Manually-operated general service type air venting valves, brass or bronze valves that are furnished with threaded plugs or caps. 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.

2.3.16 Vacuum Relief Valves

ANSI Z21.22/CSA 4.4

2.4 PIPING ACCESSORIES

2.4.1 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 monel, 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.

2.4.2 Cyclonic Separator

Metal- bodied, with removal capability of removing solids 45 microns/325 mesh in size and heavier than 1.20 specific gravity, maximum pressure drop of 5 psid, with cleanout connection.

2.4.3 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 monel, 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.

2.4.4 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.

2.4.5 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.

2.4.6 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.

2.4.6.1 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.

2.4.6.2 Bimetallic Dial

Bimetallic dial type case shall be not less than [3-1/2 inches](#), stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment.

2.4.6.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases shall be not less than [3-1/2 inches](#), stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

2.4.6.4 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](#).

2.4.7 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports: to [MSS SP-58](#) and [MSS SP-69](#). If ferrous materials are utilized provide hot-dipped galvanized hangers, inserts and supports.

2.4.8 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.

2.4.9 [Expansion Joints](#)

2.4.9.1 Slip-Tube Type

Slip-tube expansion joints, [ASTM F1007](#), Class I or II. Joints shall be

provided with internally-externally alignment guides, injected semi-plastic packing, and service outlets. End connections shall be flanged or beveled for welding as indicated. Initial settings shall be made in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer.

2.4.9.2 Flexible Ball Type

Flexible ball expansion joints shall be capable of 360 degrees rotation plus 15 degrees angular flex movement. Joints shall be constructed of carbon steel with the exterior spherical surface of carbon steel balls plated with a minimum 5 mils of hard chrome in accordance with EJMA Stds. Joint end connections shall be threaded for piping 2 inches or smaller. Joint end connections larger than 2 inches shall be grooved, flanged, or beveled for welding. Provide joint with pressure-molded composition gaskets suitable for continuous operation at twice design temperature.

2.4.9.3 Bellows Type

Bellows expansion type joints, ASTM F1120 with Type 304 stainless steel corrugated bellows, reinforced with equalizing rings, internal sleeves, and external protective covers. Joint end connections shall be grooved, flanged, or beveled for welding. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint.

2.5 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, 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.

2.5.1 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 and motor shall be mounted on a common cast iron base having lipped

edges and tapped drainage openings or structural steel base with lipped edges or drain pan and tapped drainage openings. Pump shall be provided with steel shaft coupling guard. Base-mounted pump, coupling guard, and motor shall each be bolted to a fabricated steel base which shall have bolt holes for securing base to supporting surface. Close-coupled pump shall be provided with integrally cast or fabricated steel feet with bolt holes for securing feet to supporting surface. Close-coupled pumps shall be provided with drip pockets and tapped openings. Pump shall be accessible for servicing without disturbing piping connections. Shaft seals shall be mechanical-seals or stuffing-box type.

2.5.2 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.

2.5.3 Stuffing-Box Type Seals

Stuffing box shall include minimum 4 rows of square, impregnated TFE (Teflon) or graphite cord packing and a bronze split-lantern ring. Packing gland shall be bronze interlocking split type.

2.6 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.

2.7 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 vented as indicated. Tank shall be provided with a blow-down connection.

2.8 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing equivalent chromium (CPR) is prohibited.

2.8.1 Water Analysis

Conditions of make-up water to be supplied to the condenser and chilled water systems were reported in accordance with [ASTM D596](#) and are as follows:

Date of Sample	_____
Temperature	_____ degrees F
Silica (Sino 2)	_____ pp (mg/l)
Insoluble	_____ pp (mg/l)
Iron and Aluminum Oxides	_____ pp (mg/l)
Calcium (Ca)	_____ pp (mg/l)
Magnesium (Mg)	_____ pp (mg/l)
Sodium and Potassium (Nan and AK)	_____ pp (mg/l)
Carbonate (HO 3)	_____ pp (mg/l)
Sulfate (SO 4)	_____ pp (mg/l)
Chloride (JCL)	_____ pp (mg/l)
Nitrate (NO 3)	_____ pp (mg/l)
Turbidity	_____ unit
pH	_____
Residual Chlorine	_____ pp (mg/l)
Total Alkalinity	_____ PM (me/l)
Non-Carbonate Hardness	_____ PM (me/l)
Total Hardness	_____ PM (me/l)
Dissolved Solids	_____ pp (mg/l)
Fluorine	_____ pp (mg/l)
Conductivity	_____ micromhos/cm

2.8.2 Chilled Water

Water to be used in the chilled and condenser water systems shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and

local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

2.8.3 Water Treatment Services

The services of a company regularly engaged in the treatment of condenser and chilled water systems shall be used to determine the correct chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall maintain the chemical treatment and provide all chemicals required for the condenser and chilled water systems for a period of 1 year from the date of occupancy. The chemical treatment and services provided over the 1 year period shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Acid treatment and proprietary chemicals shall not be used.

2.8.4 Chilled Water System

A shot feeder shall be provided on the chilled water piping as indicated. Size and capacity of feeder shall be based on local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

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.

Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Use solid-state variable-speed controllers for motors rated 10 hp or less and adjustable frequency drives for larger motors. Provide

variable frequency drives for motors as specified.

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](#).
- 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.

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 anodized aluminum. 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 00 PAINTS AND COATINGS.

2.13.4.1 Color Coding

Requirements for color coding for piping identification are specified in Section 09 90 00 PAINTS 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.

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.1 Welding

Provide welding work specified this section for piping systems in conformance with [ASME B31.9](#), as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, brazers, brazing operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

3.1.1.1 [Employer's Record Documents \(For Welding\)](#)

Submit for review and approval the following documentation. This documentation and the subject qualifications shall be in compliance with [ASME B31.9](#).

- a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.
- b. List of qualified welders, brazers, welding operators, and brazing operators that are proposed to be used to provide the work specified in this specification section.
- c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

3.1.1.2 [Welding Procedures and Qualifications](#)

- a. Specifications and Test Results: Submit copies of the welding procedures specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in [ASME BPVC SEC IX](#) or their equivalent.
- b. Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification shall state the type of welding and positions for which each is qualified, the code

and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

3.1.1.3 Examination of Piping Welds

Conduct non-destructive examinations (NDE) on piping welds and brazing and verify the work meets the acceptance criteria specified in [ASME B31.9](#). NDE on piping welds covered by [ASME B31.9](#) is visual inspection only. Submit a [piping welds NDE report](#) meeting the requirements specified in [ASME B31.9](#).

3.1.1.4 Welding Safety

Welding and cutting safety requirements shall be in accordance with [AWS Z49.1](#).

3.1.2 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.

3.1.3 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.

3.1.4 Fittings and End Connections

3.1.4.1 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.

3.1.4.2 Brazed Connections

Brazing, [AWS BRH](#), except as modified herein. During brazing, the pipe and

fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.4.3 Welded Connections

Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding, the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to [ASME B31.9](#). Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with [AWS D1.1/D1.1M](#) or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.4.4 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.

3.1.4.5 Flanges and Unions

Except where copper tubing is used, union or flanged 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. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for the intended application.

3.1.5 Valves

Isolation gate or 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.

3.1.6 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.

3.1.7 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.

3.1.8 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.

3.1.9 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.

3.1.10 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.

3.1.10.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.10.2 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.

3.1.10.3 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.

3.1.10.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.10.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

3.1.10.6 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.

3.1.10.7 Vertical Pipe Supports

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.

3.1.10.8 Pipe 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.

3.1.10.9 Steel Slides

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 shall be used. On piping under **4 inches**, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.10.10 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 members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.10.11 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**.

3.1.11 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed **5 feet** on each side of each expansion joint, and in lines **4 inches** or smaller not more than **2 feet** on each side of the joint.

3.1.12 Pipe Anchors

Anchors shall be provided where indicated. Unless indicated otherwise, anchors shall comply with the requirements specified. 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. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.

3.1.13 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](#), Schedule 20. 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.

3.1.13.1 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](#).

3.1.13.2 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a [.17 ounce](#) copper sleeve, or a [0.032 inch](#) thick aluminum sleeve, each within an integral skirt or flange.

Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than [8 inches](#) from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of [2 inches](#) above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

- a. Waterproofing Clamping Flange: Pipes up to and including [10 inches](#) in diameter passing through roof or floor 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.

- b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of 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. 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. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.13.3 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07 84 00 FIRESTOPPING.

3.1.13.4 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.

3.1.14 Access Panels

Access panels shall be provided where indicated for all concealed valves, vents, controls, and additionally for items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced.

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 Piping Welds

Examination of Piping Welds is specified in the paragraph EXAMINATION OF PIPING WELDS (above).

3.4.3.2 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, . 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 man-day.. 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 23 81 00

DECENTRALIZED UNITARY HVAC EQUIPMENT
05/18

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with the additions and modifications 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.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 700	(2016) Specifications for Fluorocarbon Refrigerants
ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2016) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 55	(2010) Thermal Environmental Conditions for Human Occupancy

ASHRAE 62.1 (2016) Ventilation for Acceptable Indoor Air Quality

ASHRAE 90.1 - IP (2019; Errata 1 2019; Errata 2-5 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 6-8 2021; Interpretation 1-4 2020; Interpretation 5-8 2021 Addenda AS-AQ 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

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

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1 (2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM B117 (2019) Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM C1071 (2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)

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 2 (2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5541 (2006; Rev F) Chemical Conversion Coatings on Aluminum and Aluminum Alloys

UNDERWRITERS LABORATORIES (UL)

UL 207	(2009; Reprint Jan 2020) Refrigerant-Containing Components and Accessories, Nonelectrical
UL 586	(2009; Reprint Dec 2017) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 900	(2015) Standard for Air Filter Units
UL 1995	(2015) UL Standard for Safety Heating and Cooling Equipment

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. 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

Coil Corrosion Protection

Supplied Products

Manufacturer's Standard Catalog Data

SD-06 Test Reports

Refrigerant Tests, Charging, and Start-Up; G

System Performance Tests; G

SD-07 Certificates

Service Organizations

SD-11 Closeout Submittals

Ozone Depleting Substances; S

1.4 QUALITY ASSURANCE

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. Submit drawings consisting of:

- a. Equipment layouts which identify assembly and installation details.
- b. Plans and elevations which identify clearances required for maintenance and operation.

- c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.
- d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.
- e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.
- f. Automatic temperature control diagrams and control sequences.
- g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.
- h. Equipment schedules

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Properly protect and care for all material both before and during installation. Replace any materials found to be damaged, at no additional cost to the Government. During installation, cap piping and similar openings capped to keep out dirt and other foreign matter.

1.6 ENVIRONMENTAL REQUIREMENTS

For proper Indoor Environmental Quality, maintain pressure within the building as indicated. Ventilation must meet or exceed [ASHRAE 62.1](#) and all published addenda. Meet or exceed filter media efficiency as tested in accordance with [ASHRAE 52.2](#). Thermal comfort must meet or exceed [ASHRAE 55](#).

1.7 WARRANTY

Provide equipment with the Manufacturer's Standard Warranty.

PART 2 PRODUCTS

2.1 ENERGY EFFICIENCY REQUIREMENTS

42 USC 8259b requires the procurement of energy efficient products in product categories covered by the Energy Star program or the Federal Energy Management Program for designated products. A list of covered product categories is available from the Federal Energy Management Web site at <http://energy.gov/eere/femp/covered-product-categories>. [A list of qualified light commercial products is available at http://www.energystar.gov/productfinder/product/certified-light-commercial-hvac/result](#)

Submit Material, Equipment, and Fixtures List of all [supplied products](#) within a covered product category, including manufacturer's catalog numbers, specification and drawing reference number, warranty information, fabrication site, and energy performance data. [For product categories covered by the Energy Star program, submit documentation that the product is Energy Star-qualified.](#) For product categories covered by the Federal Energy Management Program, submit documentation that the product meets or exceeds FEMP-designated efficiency requirements.

2.1.1.1 Air-Source Heat Pumps

Selected air-source heat pumps are required to meet applicable performance requirements specified by Energy Star. Information on the requirements can be found for residential models (single-phase units of 65,000 BTU/h or less) at

http://www.energystar.gov/products/specs/system/files/Central_ASHP_and_CAC_Program_Req_v4_1.pdf and for light commercial models (three-phase units of less than 240,000 BTU/h) at

http://www.energystar.gov/products/specs/system/files/lchvac_prog_req_v2_2_0.pdf.

2.2 MATERIALS

Provide [Manufacturer's standard catalog data](#), at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data includes manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Submit data for each specified component. Minimum efficiency requirements must be in accordance with [ASHRAE 90.1 - IP](#).

2.2.1 Standard Products

Provide materials and equipment that are 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 must have been in satisfactory commercial or industrial use for 2 years prior to request for proposal. The 2 year use includes applications of equipment and materials under similar circumstances and of similar size. The 2 years' experience must 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 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. Products must be supported by a service organization. Ensure system components are environmentally suitable for the indicated geographic locations.

2.2.2 Product Sustainability Criteria

2.2.2.1 Energy Efficient Equipment

Provide equipment meeting the efficiency requirements as stated within this section and provide documentation in conformance with Section [01 33 29 SUSTAINABILITY REPORTING](#) paragraph ENERGY EFFICIENT EQUIPMENT.

2.2.2.2 Electrical Equipment / Motors

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Section [26 20 00 INTERIOR DISTRIBUTION SYSTEM](#). Electrical motor driven equipment specified must be provided complete with motors, motor starters, and controls. Electrical characteristics must be

as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, must be the premium efficiency type in accordance with NEMA MG 1. Field wiring must be in accordance with manufacturer's instructions. Each motor must conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors must be continuous duty with the enclosure specified. Motor starters must be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors must be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors must be sized for the applicable loads. 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. Motor bearings must be fitted with grease supply fittings and grease relief to outside of enclosure. 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, must be provided.

2.2.2.3 Ozone Depleting Substances

Unitary air conditioning equipment must not use CFC-based refrigerants. Refrigerant may be an approved alternative refrigerant in accordance with EPA's Significant New Alternative Policy (SNAP) listing. Provide documentation in conformance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph OZONE DEPLETING SUBSTANCES.

2.2.3 Nameplates

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors 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 and made of stainless steel. Fix plates in prominent locations with nonferrous screws or bolts.

2.2.4 Safety Devices

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.

2.3 EQUIPMENT

2.3.1 Split-System Air Conditioners Heat Pumps

2.3.1.1 Small-Capacity Split-System Air-Conditioners (Not Exceeding 65,000 Btu/hr)

Provide an air-cooled, split system which employs a remote condensing unit, a separate ceiling mounted indoor unit, and interconnecting refrigerant piping. Provide the heat pump type unit conforming to applicable Underwriters Laboratories (UL) standards including UL 1995.

Unit must be rated in accordance with ANSI/AHRI 210/240. Provide indoor unit with necessary fans, air filters, and galvanized steel cabinet construction. The remote unit must be as specified in paragraph CONDENSING UNIT. Provide double-width, double inlet, forward curved backward inclined, or airfoil blade, centrifugal scroll type evaporator or supply fans. Provide the manufacturer's standard condenser or outdoor fans for the unit specified and may be propeller type. Fan and condenser motors must have totally enclosed enclosures. Design unit to operate at outdoor ambient temperatures up to 115 degrees F.

2.3.1.1.1 Air-to-Refrigerant Coil

Provide condensing coils with copper tubes of 3/8 inch minimum diameter with aluminum fins that are mechanically bonded or soldered to the tubes. Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil testing and prior to evaluation and charging.

Coat condenser and evaporator coil with a uniformly applied epoxy electrodeposition, phenolic, or vinyl type coating to all coil surface areas without material bridging between fins. Apply coating at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation and be capable of withstanding a minimum 3000 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.3.1.1.2 Compressor

Provide direct drive scroll type compressor. Provide compressor with internal over temperature and pressure protector; sump heater; oil pump; high pressure and low pressure controls; and liquid line dryer.

2.3.1.1.3 Refrigeration Circuit

Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide refrigerant charging valves. Provide filter-drier in liquid line to prevent freeze-up in event of loss of water flow during heating cycle.

2.3.1.1.4 Unit Controls

Provide unit internally prewired with a 24 volt control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Internally protect unit by fuses or a circuit breaker in accordance with UL 1995. Equip units with three-phase power with phase monitoring protection to protect against problems caused by phase loss, phase imbalance and phase reversal. Provide unit with microprocessor controls to provide all 24V control functions.

Controls must include a control system interface to a BACnet Control system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.

Communication networks between physically separate units in a split system must be in accordance with 23 09 23.13 BACnet DIRECT DIGITAL CONTROL

SYSTEMS FOR HVAC2.3.1.1.5 Condensing Coil

Provide coils with copper tubes of 3/8 inch minimum diameter with aluminum fins that are mechanically bonded or soldered to the tubes. Protect coil in accordance with paragraph CORROSION PROTECTION. Provide galvanized steel or aluminum casing. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide separate expansion devices for each compressor circuit.

2.3.1.1.6 Remote Condenser or Condensing Unit

Fit each remote condenser coil fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 120 degrees F at 104 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of 20degrees F. Provide fan and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. Fan and condenser motors must have totally enclosed enclosures. 2.3.1.1.6.1 Air-Cooled Condenser

Provide Unit in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Provide factory fabricated, tested, packaged, and self-contained unit; complete with casing, propeller type fans, heat rejection coils, connecting piping and wiring, and all necessary accessories.

2.3.1.1.7 Primary/Supplemental Heat

Provide heating unit with internal thermal insulation having a fire hazard rating not to exceed 25 for flame spread and 50 for smoke developed as determined by ASTM E84.

2.3.1.1.7.1 Electric Heating

Construct electric heater of heavy-duty nickel chromium elements. Achieve staging through the unit control processor. Each heater must have automatically reset high limit control. Heaters must be individually fused from the factory and comply with NEC requirements. Power assemblies must provide single point connection. Electric heat modules must be listed and labeled by a national recognized testing laboratory acceptable to authorities having jurisdiction. Electric heater controls must confirm the supply fan is operating before electric elements are energized. Operate electric heater in stages when outdoor ambient is too low to maintain space thermostat setting with compressor operation.

2.3.1.1.8 Air Filters

Provide filters of the panel type that are capable of filtering the entire air supply. Mount filter(s) integral within the unit and make accessible by hinged access panel(s). 2 inch MERV 13, provide throwaway filter on all units below 6 Tons.

Provide filter rack that can be converted to 2.0 inch capability. Filters must be MERV 13. Provide UL Class 1 filters.

2.3.1.1.9 Fans

Provide direct driven, statically and dynamically balanced, centrifugal type fans. Design the outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan with a minimum two-speed motor with built-in overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.

2.4 COMPONENTS

2.4.1 Refrigerant and Oil

Refrigerant must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with [ASHRAE 15 & 34](#). Refrigerants must meet the requirements of [AHRI 700](#) as a minimum. Provide a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil must be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge must be in accordance with manufacturer's recommendation.

2.4.2 Fans

Fan wheel shafts must be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans must be selected to produce the [cfm](#) required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a open enclosure. Thermal overload protection must be of the manual or automatic-reset type. Fan wheels or propellers must be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings must be of galvanized steel, and both centrifugal and propeller fan casings must be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, must be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting must be recoated with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Direct-drive fan motors must be of the multiple-speed variety.

2.4.3 Primary/Supplemental Heating

2.4.3.1 Electric Heating Coil

Coil must be an electric duct heater in accordance with [UL 1995](#) and [NFPA 70](#). Coil must be duct- or unit-mounted. Coil must be of the nickel chromium resistor, single stage, strip type. Coil must be provided with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Coil casing and support brackets must be of galvanized steel or aluminum. Coil must be mounted to eliminate noise from expansion and contraction and be completely accessible for service. Supplemental Electric Resistance Heating controls must be provided to prevent operation when the heating load can be met by the primary source.

2.4.4 Air Filters

Provide filters to filter outside air and return air and locate inside air conditioners . Provide replaceable (throw-away) type. Filters must

conform to [UL 900](#), Class 1 . Polyurethane filters cannot be used on units with multiframe filters.

Air filters must be listed in accordance with requirements of [UL 900](#), except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method must be as listed under the label service and must meet the requirements of [UL 586](#).

2.4.4.1 Extended Surface Pleated Panel Filters

Filters must be [2 inch](#) depth sectional type of the size indicated and must have an average efficiency of 25 to 30 percent when tested in accordance with [ASHRAE 52.2](#). Initial resistance at [500 feet/minute](#) must not exceed [0.36 inches water gauge](#). Filters must be UL Class 2. Media must be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media must be attached to a moisture resistant fiberboard frame. Four edges of the filter media must be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.4.5 Coil Frost Protection

Provide each circuit with a manufacturer's standard coil frost protection system. The coil frost protection system must use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Use timers to prevent the compressor from rapid cycling.

2.4.6 Pressure Vessels

Pressure vessels must conform to [ASME BPVC SEC VIII D1](#) or [UL 207](#), as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, test pressure components at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces must be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.4.6.1 Hot Gas Muffler

Unit must be selected by the manufacturer for maximum noise attenuation. Units rated for [30 tons](#) capacity and under may be field tunable type.

2.4.6.2 Liquid Receiver

A liquid receiver must be provided when a system's condenser or compressor does not contain a refrigerant storage capacity of at least 20 percent in excess of a fully charged system. Receiver must be designed, filled, and rated in accordance with the recommendations of [ANSI/AHRI 495](#), except as modified herein. Receiver must be fitted to include an inlet connection; an outlet drop pipe with oil seal and oil drain where necessary; two bull's-eye liquid level sight glass in same vertical plane, 90 degrees apart and perpendicular to axis of receiver or external gauge glass with metal guard and automatic stop valves; and purge, charge, equalizing, pressurizing, plugged drain and service valves on the inlet and outlet connections. Receiver must be provided with a relief valve of capacity and setting in accordance with [ASHRAE 15 & 34](#).

2.4.7 Cabinet Construction

Casings for the specified unitary equipment must be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum

structural members. Minimum thickness of single wall exterior surfaces must be 18 gauge galvanized steel or 0.071 inch thick aluminum on units with a capacity above 20 tons and 20 gauge galvanized steel or 0.064 inch thick aluminum on units with a capacity less than 20 tons. Casing must be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness must be 20 gauge. Provisions to permit replacement of major unit components must be incorporated. Penetrations of cabinet surfaces, including the floor, must be sealed. Unit must be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan must be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071. Paint and finishes must comply with the requirements specified in paragraph FACTORY COATING.

2.4.7.1 Indoor Cabinet

Indoor cabinets must be suitable for the specified indoor service and enclose all unit components.

2.4.8 Refrigerant Piping

Provide refrigerant piping in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.4.9 Condensate Drain Piping

provide condensate drain piping in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.4.10 Ductwork

Provide ductwork in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.4.11 Temperature Controls

Temperature controls shall be in accordance with 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.

2.5 FINISHES

2.5.1 Coil Corrosion Protection

Provide coil with a uniformly applied epoxy electrodeposition, phenolic, or vinyl type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Coating must be applied at either the coil or

coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum 3000 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.5.2 Equipment and Components 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 3000 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.

Where stipulated in equipment specifications of this section, coat finned tube coils of the affected equipment as specified below. Apply coating at the premises of a company specializing in such work. Degrease and prepare for coating in accordance with the coating applicator's procedures for the type of metals involved. Completed coating must show no evidence of softening, blistering, cracking, crazing, flaking, loss of adhesion, or "bridging" between the fins.

2.5.2.1 Phenolic Coating

Provide a resin base thermosetting phenolic coating. Apply coating by immersion dipping of the entire coil. Provide a minimum of two coats. Bake or heat dry coils following immersions. After final immersion and prior to final baking, spray entire coil with particular emphasis given to building up coating on sheared edges. Total dry film thickness must be 2.5 to 3.0 mils.

2.5.2.2 Chemical Conversion Coating with Polyelastomer Finish Coat

Dip coils in a chemical conversion solution to molecularly deposit a corrosion resistant coating by electrolysis action. Chemical conversion coatings must conform to MIL-DTL-5541, Class 1A. Cure conversion coating at a temperature of 110 to 140 degrees F for a minimum of 3 hours. Coat coil surfaces with a complex polymer primer with a dry film thickness of 1 mil. Cure primer coat for a minimum of 1 hour. Using dip tank method, provide three coats of a complex polyelastomer finish coat. After each of the first two finish coats, cure the coils for 1 hour. Following the third coat, spray a fog coat of an inert sealer on the coil surfaces. Total dry film thickness must be 2.5 to 3.0 mils. Cure finish coat for a minimum of 3 hours. Coating materials must have 300 percent flexibility, operate in temperatures of minus 50 to plus 220 degrees F, and protect against atmospheres of a pH range of 1 to 14.

2.5.2.3 Vinyl Coating

Apply coating using an airless fog nozzle. For each coat, make at least two passes with the nozzle. Materials to be applied are as follows:

- a. Total dry film thickness, 6.5 mils maximum

- b. Vinyl Primer, 24 percent solids by volume: One coat 2 mils thick
- c. Vinyl Copolymer, 30 percent solids by volume: One coat 4.5 mils thick

2.5.3 Factory Applied Insulation

Refrigeration equipment must be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor in accordance with 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.

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

All manufactured units must be inspected and tested, and documentation provided to demonstrate that each unit is in compliance with ANSI/AHRI and UL requirements and that the minimum efficiency requirements of ASHRAE 90.1 - IP have been met.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

Perform work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1 and ASME BPVC SEC IX, the design, fabrication, and installation of the system must conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.2.1 Equipment

Provide refrigeration equipment conforming to ASHRAE 15 & 34. Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Isolate compressors from the building structure. If mechanical vibration isolators are not provided, provide vibration absorbing foundations. Each foundation must include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment must be set on not less than a 6 inch concrete pad doweled in place. Concrete

foundations for floor mounted pumps must have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the combined pump, motor, and base weights. Isolators must be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators must limit vibration to 10 percent at lowest equipment rpm. Provide lines connected to pumps mounted on pedestal blocks with flexible connectors. Provide foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.2.2 Field Applied Insulation

Apply field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.2.3 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 CLEANING AND ADJUSTING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters must be provided for all fans that are operated during construction, and new filters must be installed after all construction dirt has been removed from the building. System must be maintained in this clean condition until final acceptance. 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. Testing, adjusting, and balancing must be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems must be tested and charged as specified in Section 23 23 00 REFRIGERANT PIPING. Packaged refrigerant systems which are factory charged must be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems must be tested for leaks with a halide torch or an electronic leak detector. Submit 6 copies of each test containing the information described below in bound 8-1/2 by 11 inch booklets. Individual reports must be submitted for the refrigerant system tests.

- a. The date the tests were performed.
- b. A list of equipment used, with calibration certifications.
- c. Initial test summaries.
- d. Repairs/adjustments performed.

- e. Final test results.

3.4.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances must the refrigerant be discharged into the atmosphere.

3.4.2 Contractor's Responsibility

Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time must more than **3 ounces** of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year must be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.5 **SYSTEM PERFORMANCE TESTS**

Before each refrigeration system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Six copies of the report provided in bound **8-1/2 by 11 inch** booklets. 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.

For equipment providing heating and cooling the system performance tests must be performed during the heating and cooling seasons.

- a. Submit 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. 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.
- b. Make corrections and adjustments, as necessary, tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, install and tighten service valve seal caps and blanks over gauge points. Replace any refrigerant lost during the system startup.
- c. If tests do not demonstrate satisfactory system performance, correct deficiencies and retest the system. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test.
- d. Coordinate field tests with Section **23 05 93 TESTING, ADJUSTING, AND**

BALANCING OF HVAC SYSTEMS. Submit 6 copies of the report provided in bound 8-1/2 by 11 inch booklets. 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. Submit the report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart):

- (1) Date and outside weather conditions.
- (2) The load on the system based on the following:
 - (a) The refrigerant used in the system.
 - (b) Condensing temperature and pressure.
 - (c) Suction temperature and pressure.
 - (d) Ambient, condensing and coolant temperatures.
 - (e) Running current, voltage and proper phase sequence for each phase of all motors.
- (3) The actual on-site setting of operating and safety controls.
- (4) Thermostatic expansion valve superheat - value as determined by field test.
- (5) Subcooling.
- (6) High and low refrigerant temperature switch set-points
- (7) Low oil pressure switch set-point.
- (8) Defrost system timer and thermostat set-points.
- (9) Moisture content.
- (10) Capacity control set-points.
- (11) Field data and adjustments which affect unit performance and energy consumption.
- (12) Field adjustments and settings which were not permanently marked as an integral part of a device.

3.6 MAINTENANCE

3.6.1 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. Include in the data 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.

3.6.2 Maintenance Service

Submit a certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations must 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.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 25 05 11

CYBERSECURITY FOR FACILITY-RELATED CONTROL 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 only and enables coordination of the requirements of this Section with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

This Section refers to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs). STIGs and SRGs are available online at the Information Assurance Support Environment (IASE) website at <https://public.cyber.mil/stigs/downloads/> and 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 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, and as these requirements 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.

In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the Contracting Officer Representative to determine which requirement applies to the project.

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.

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

NIST FIPS 201-2 (2013) Personal Identity Verification
(PIV) of Federal Employees and Contractors

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 8551.01 (2014) Ports, Protocols, and Services
Management (PPSM)

DTM 08-060 (2008) Policy on Use of Department of
Defense (DoD) Information Systems -
Standard Consent Banner and User Agreement

1.3 DEFINITIONS

1.3.1 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 'Administrator Account'.

1.3.2 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.

1.3.3 Controller

A device other than a computer or Ethernet switch. For Fire Protection systems this includes fire alarm control panels, remote operating consoles, and remote annunciators.

1.3.4 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.

1.3.5 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.

1.3.6 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).

1.3.6.1 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.

1.3.7 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).

1.3.8 User Account Support Levels

The support for user accounts is categorized in this Section as one of three levels:

1.3.8.1 FULLY Supported

Device supports configurable individual accounts. Accounts can be created, deleted, modified, etc. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

1.3.8.2 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 PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, 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 configuration; and b) a room lighting control touchpad interface that has a single account.

1.3.8.3 NOT Supported

Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.

1.3.9 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 lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.3.10 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, touchscreen, etc.) for a user to input a PIN or password, as well as a limited display.

1.3.11 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 its 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

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 the user is logged into).

1.3.11.1 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".

1.3.11.2 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 remote 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.

1.3.11.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.3.11.3.1 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.

1.3.11.3.2 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.

1.3.11.3.3 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 Full Local User Interface while a browser-based front end is a Full Remote User Interface.

1.3.11.3.4 View-Only User Interface

See Read-Only User Interface

1.3.11.4 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.

1.3.11.4.1 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)).

1.3.11.4.2 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. Ultimately, whether a specific user interface is considered a Privileged User Interface must be determined by usage. Unless otherwise specified, user interfaces can be determined 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. For all other systems, Full User Interfaces are privileged user interfaces.
- c. User interfaces that allow for configuration of auditing or allows for modification or deletion of audit logs are privileged user interface.

- 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.

1.3.12 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 IR.

1.3.13 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.

1.4 ADMINISTRATIVE REQUIREMENTS

1.4.1 Points of Contact

Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with The Contracting Office Representative (COR).

- a. Government Computer Access Point of Contact: The Contracting Office Representative (COR)
- b. HTTPS Certificate Point of Contact: The Contracting Office Representative (COR)
- c. Email Address Point of Contact: The Contracting Office Representative (COR)
- d. Password Point of Contact: The Contracting Office Representative (COR)
- e. Mobile Code Point of Contact: The Contracting Office Representative (COR)
- f. PKI Infrastructure Point of Contact: The Contracting Office Representative (COR)

1.4.2 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 must 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 must be coordinated across control systems and with the Government cybersecurity testing schedule.
- h. Passwords must 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.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Wireless and Wired Broadcast Communication Request; G

Device Account Lock Exception Request; G

Multiple Ethernet Connection Device Request; G

Contractor Computer Cybersecurity Compliance Statements; G

Contractor Temporary Network Cybersecurity Compliance Statements; G

Cybersecurity Interconnection Schedule; G

Protection of Information At Rest Proposal; G

Proposed STIG and SRG Applicability Report; G

SD-02 Shop Drawings

Network Communication Report; G

Cybersecurity Riser Diagram; G

SD-03 Product Data

Control System Cybersecurity Documentation; G

SD-06 Test Reports

Wireless Communication Test Report; G

Control System Cybersecurity Testing Procedures; G

Control System Cybersecurity Testing Report; G

SD-07 Certificates

Software Licenses; G

SD-11 Closeout Submittals

Password Change Summary Report; G

Enclosure Keys; G

Software and Configuration Backups; G

Auditing Front End Software; G

Device Audit Record Upload Software; G

System Maintenance Tool Software; G

Control System Scanning Tools; G

STIG, SRG and Vendor Guide Compliance Result Report; G

Control System Inventory Report; G

Integrity Verification Software; G

1.6 QUALITY CONTROL

1.7 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.7.1 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.

1.7.2 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. For communication with other authorized systems also provide the Foreign Destination and POC for Destination. 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>

1.7.3 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; 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.

1.7.4 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}

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 networked devices, including network infrastructure devices. 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.

1.7.5 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 referencing those submittals.

1.7.6 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.

1.7.7 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.

1.7.8 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.

1.7.8.1 Software Applications

For all software applications running on computers provide:

- a. administrator documentation that describes secure configuration of the software {For Government Reference Only: relates to CCI-003124}
- b. administrator documentation that describes secure installation of the software {For Government Reference Only: relates to CCI-003125}
- c. administrator documentation that describes secure operation of the software {For Government Reference Only: relates to CCI-003124}
- d. administrator documentation that describes effective use and maintenance of security functions or mechanisms for the software {For Government Reference Only: relates to CCI-003127}
- e. administrator documentation that 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 that 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 that 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 that describes user responsibilities in maintaining the security of the software {For Government Reference Only: relates to CCI-003131}

1.7.8.2 For HVAC Control System Devices

1.7.8.2.1 HVAC Control System Devices FULLY Supporting User Accounts

For all HVAC 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}

1.7.8.2.2 All Other HVAC Control System Devices

For all HVAC 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}

1.7.8.3 For Lighting Control System Devices

1.7.8.3.1 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}

1.7.8.3.2 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}

1.7.8.4 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}

1.8 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

1.9 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 following requirement throughout the construction process.

1.9.1 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:

1.9.1.1 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.

1.9.1.2 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.

1.9.1.3 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.

1.9.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.9.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.9.1.6 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.

1.9.2 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:

1.9.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must 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.

1.9.3 Government Access to Network

Government personnel must be allowed to have complete and immediate access

to the network at any time in order to verify compliance with this specification.

1.9.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.

1.9.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.9.6 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 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. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.10 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance must 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, but not all products specified here will be required by every project.

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 must:

- a. Copper Ethernet ports must 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.

2.1.2 Configuration Requirements

Switches must:

- 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.

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 must 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 required functionality or another requirement of this Section.

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. If requesting authorization for wireless or wired broadcast communication, wired broadcast media such as powerline carrier is preferred to wireless.

3.2.3.1 Wireless and Wired Broadcast IP Communications

Do not install wireless or wired broadcast IP networks; 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

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 [approved by the Contracting Officer](#). 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 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 must 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 must use HTTPS instead. Devices using Fox Protocol must support IEEE 802.1x.

3.2.7.2 For Lighting Control System Devices

Devices using HTTP as a control protocol must use HTTPS instead. Devices using Fox Protocol must support IEEE 802.1x.

3.2.7.3 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 HTTP as a control protocol must use HTTPS instead.

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-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 must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must 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 must FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer must be installed such that use of the software is restricted by the computer operating system to specific users.

Applications running on computers must 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 must at least MINIMALLY support user accounts.
- d. For table entries of "FULLY": The user interface must at FULLY support user accounts.
- e. For table entries of "KEY": The user interface must 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 must prevent viewing of data on the interface; for other interfaces, this lock must prevent using the interface to alter data.
- f. For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must 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 that 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" must 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 must both MINIMALLY support accounts and have physical security.
- h. Entries of the form "X or Y" must 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	
<u>User Interface Type</u>	<u>Access Control Requirement</u>
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

User Interface Requirements for LOW Impact HVAC Control Systems	
<u>User Interface Type</u>	<u>Access Control Requirement</u>
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	
User Interface Requirements for MODERATE Impact HVAC Control Systems	
<u>User Interface Type</u>	<u>Access Control Requirement</u> (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: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2.2 Lighting Control Systems

User Interface Requirements for LOW Impact Lighting Control Systems	
<u>User Interface Type</u>	<u>Access Control Requirement</u>
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	None Required
Local Limited, Privileged	MINIMALLY
Local Full	MINIMALLY

User Interface Requirements for LOW Impact Lighting Control Systems	
<u>User Interface Type</u>	<u>Access Control Requirement</u>
Remote Read Only	None Required
Remote Limited, Non-Privileged	MINIMALLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	
User Interface Requirements for MODERATE Impact Lighting Control Systems	
<u>User Interface Type</u>	<u>Access Control Requirement</u> (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: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2.3 Electronic Security Systems (ESS)

User Interface Requirements for LOW Impact Electronic Security Systems	
<u>User Interface Type</u>	<u>Access Control Requirement</u>
Local Read Only (see note 1)	KEY
Local Limited, Non-privileged	NA

User Interface Requirements for LOW Impact Electronic Security Systems	
<u>User Interface Type</u>	<u>Access Control Requirement</u>
Local Limited, Privileged	MINIMALLY and KEY
Local Full	FULLY and Physical Security
Remote Read Only	None Required
Remote Limited, Non-Privileged	NA
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	
User Interface Requirements for MODERATE Impact Electronic Security Systems	
<u>User Interface Type</u>	<u>Access Control Requirement</u> (See note 3)
Local Read Only (see note 1)	KEY
Local Limited, Non-privileged	NA
Local Limited, Privileged	FULLY
Local Full	FULLY and Physical Security
Remote Read Only	None Required
Remote Limited, Non-Privileged	NA
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2.4 Fire Protection Systems

User Interface Requirements for LOW Impact Fire Protection Systems	
<u>User Interface Type</u>	<u>Access Control Requirement</u>
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	KEY or MINIMALLY
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	
<u>User Interface Type</u>	<u>Access Control Requirement</u> (See note 2)
Local Read Only	None Required
Local Limited, Non-privileged	KEY or MINIMALLY
Local Limited, Privileged	KEY and Physical Security
Local Full	KEY
Remote Read Only	MINIMALLY
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2.5 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	
<u>User Interface Type</u>	<u>Access Control Requirement</u>
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: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	
Default User Interface Requirements for MODERATE Impact Control Systems	
<u>User Interface Type</u>	<u>Access Control Requirement</u> (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: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 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 must 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 must 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 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.

3.3.3 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 must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must 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 must be machine printed or engraved, plastic or metal, designed for permanent installation, must 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 must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session Termination must 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 must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must 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 must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen. No interaction with the user interface must be possible until either a)

the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must 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 must support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination must be capable of being initiated by the user and must also be initiated by lack of activity. Session Lock must occur after 15 minutes of inactivity, and Session Termination must 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.

Other User Interface sessions running on computers (for local user interfaces) or hosted on a computer (for remote user interfaces) and supporting accounts must support user initiation of Session Termination. In addition, remote User Interface sessions must also initiate Session Termination after 30 minutes of inactivity.

3.3.4.4 Session Lock and Termination for Controllers

Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after 30 minutes of inactivity.

Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must 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 Physical 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 Suppression Systems which can 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 Suppression systems with a release panel, install all components of the suppression 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 preceding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the system, 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.

3.4.2 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.

3.4.3 Password-Based Authentication Requirements

3.4.3.1 Passwords for Software and Applications Running on Computers

All software and applications running on computers supporting password-based authentication must enforce the following requirements:

- a. Minimum password length of 12 characters
- b. Password must contain at least one uppercase character.
- c. Password must contain at least one lowercase character.
- d. Password must contain at least one numeric character.
- e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.
- f. Password must have a minimum lifetime of 24 hours.
- g. Password must 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 must 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 must be cryptographically protected during storage and transmission.

3.4.3.2 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts and supporting password-based authentication must enforce the following requirements:

- a. Minimum password length of twelve (12) characters
- b. Password must contain at least one uppercase character.
- c. Password must contain at least one lowercase character.
- d. Password must contain at least one numeric character.
- e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.
- f. Password must 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 must differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.
- h. Passwords must be cryptographically protected during storage and transmission.

3.4.3.3 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication must enforce the following requirements:

- a. Minimum password length of twelve (12) characters
- b. Password must contain at least one uppercase character.
- c. Password must contain at least one lowercase character.
- d. Password must contain at least one numeric character.
- e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.
- f. Password must 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 must 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 must be cryptographically protected during storage and transmission.

3.4.3.4 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of four characters.

3.4.3.5 Password Configuration and Reporting

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.

3.4.4 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.

3.5 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(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-012300133, 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.

3.5.1.3 For Lighting Control System Controller

3.5.1.3.1 Lighting 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.

3.5.1.3.1.1 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.

3.5.1.3.1.2 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

3.5.1.3.2 Other Lighting Control System Controllers

There are no requirements to perform auditing at Lighting field controllers that do not FULLY support accounts.

3.5.1.4 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:

3.5.1.4.1 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.

3.5.1.4.1.1 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.

3.5.1.4.1.2 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

3.5.1.4.2 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

The project site currently has the following software to support control system auditing: none. 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 and install the software on the control system front end computer. 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 controllers 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.

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 must provide email notification to the System Security Officer and the Information Controls Assessor. 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 must 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-000382, 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-000382, 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 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.

3.7.2.2 Network Reliance in MODERATE Impact Lighting 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.

3.7.2.3 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.

3.7.5 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 normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal

3.7.5.2 Fire Suppression System Network Isolation

For fire suppression systems including a release panel, any network used in these systems must be dedicated to these systems and must be isolated from any other network, including other components of the Fire Alarm and Fire Suppression systems. Use only dry contacts and relays to transfer signals from these systems to any other systems. Install relays using the normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal

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 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 must 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 must meet relevant vulnerability scanning STIGs/SRGs and respond to approved DoD vulnerability scanning tools.

3.11.2 Controllers

Provide controllers that are 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 must 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}

Devices in the following systems which implement PIV must be on the [NIST FIPS 201-2](https://www.idmanagement.gov/approved-products-list/) approved product list (<https://www.idmanagement.gov/approved-products-list/>): NONE.

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.
- b. Provide malware protection software media.
- c. Install 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 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

Provide eight hours of classroom and hands-on training for six Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.

The Government will provide the training location. Training must 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 must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

SECTION 26 08 00

APPARATUS INSPECTION AND TESTING

11/21

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.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2021) 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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance Tests and Inspections; G

SD-07 Certificates

Qualifications of Organization, and Lead Engineering Technician; G

Acceptance Test and Inspections Procedure; G

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 (Level III) 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:

- b. Section **26 12 19.10** THREE-PHASE, LIQUID-FILLED PAD-MOUNTED TRANSFORMERS
- d. Section **33 71 01** OVERHEAD TRANSMISSION AND DISTRIBUTION
- e. Section **33 71 02** UNDERGROUND ELECTRICAL DISTRIBUTION. Medium voltage cables and grounding systems only.

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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 12 19.10

THREE-PHASE, LIQUID-FILLED PAD-MOUNTED TRANSFORMERS
05/19, CHG 1: 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.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1 (2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M (2020a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

ASTM C260/C260M (2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete

ASTM D92 (2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester

ASTM D97 (2017b) Standard Test Method for Pour Point of Petroleum Products

ASTM D117 (2018) Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids

ASTM D877/D877M (2019) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

ASTM D1535 (2014; R 2018) Standard Practice for Specifying Color by the Munsell System

ASTM D3487 (2016; E2017) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

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	(2023) 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	(2021) 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	(2015) Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 10 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	(2021) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests
IEEE C62.11	(2020) 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	(2021) 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; R 2017) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) 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 (2022) 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" or "S"
classification. Submittals not having a "G" or "S" classification are for
Contractor Quality Control approval. Submit the following in accordance
with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pad-mounted Transformer Drawings; G

SD-03 Product Data

Pad-mounted Transformers; G

SD-06 Test Reports

Acceptance Checks and Tests; G

SD-07 Certificates

Transformer Efficiencies; G

SD-09 Manufacturer's Field Reports

Transformer Test Schedule; G

Pad-mounted Transformer Design Tests; G

Pad-mounted Transformer Routine and Other Tests; G

SD-10 Operation and Maintenance Data

Transformer(s), Data Package 5; G

1.4.1 Reduced Submittal Requirements

Transformers designed and manufactured by ABB in Jefferson City, MO; by Eaton'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, submit the following items:

- 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).
- e. Provide transformer test schedule and routine and other tests required by submittal item "SD-09 Manufacturer's Field Reports".
- 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 with terminals identified of watt-hour meter and current transformers.
- d. One-line diagram, including switch(es), current transformers, meters, and fuses.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, except of NFPA 70 when more stringent requirements are specified or indicated, 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. 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(s) 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. Information on watthour demand meter, CT's, and fuse block
- g. Actual nameplate diagram

h. 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 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION, 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, feed-thru 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 with insulated standoff bushings, protective caps, 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 must have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.
- c. Bushing well inserts and feed-thru inserts: IEEE 386, 200 amperes, 15 kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise. Provide feed-thru inserts as indicated.
- 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
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 with oil-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 six arresters for loop feed circuits.
- h. Parking stands: Provide a parking stand near each bushing. Provide insulated standoff bushings for parking of energized high-voltage connectors on parking stands.
- i. Protective caps: [IEEE 386](#), 200 amperes, 15 kV Class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushings.

2.2.1.2 Low Voltage

Low-voltage compartment contains: low-voltage bushings with NEMA spade

terminals, accessories, metering, 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.
- b. Metering: Provide as specified in Section 26 27 14.00 20 ELECTRICITY METERING.

2.2.2 Transformer

- a. Less-flammable bio-based liquid-insulated, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.
- b. Transformer rated as indicated kVA.
- c. Transformer voltage ratings: as indicated
- 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.
- (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.

<u>kVA</u>	<u>EFFICIENCY</u> <u>(percent)</u>
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](#), ultimately biodegradable as designated by EPA.
 - (3) Trout toxicity: [OECD Test 203](#), zero mortality of [EPA 821-R-02-012](#), pass
- b. Mineral oil: [ASTM D3487](#), Type II, tested in accordance with [ASTM D117](#). Provide identification of transformer as "non-PCB" and "Type II mineral oil" on the nameplate.

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

Provide corrosion resistant bases and cabinets of transformers, fabricated of stainless steel conforming to [ASTM A240/A240M](#), Type 304 or 304L. Base includes any part of pad-mounted transformer that is within 3 inches of concrete pad.

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 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.

- b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "WARNING HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on an orange and black field.

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 PADLOCKS

Provide padlocks for pad-mounted equipment and for each fence gate, keyed as directed by the Contracting Officer. Comply with Section 08 71 00 DOOR HARDWARE.

2.7 CAST-IN-PLACE CONCRETE

Provide concrete associated with electrical work as follows:

- a. Composed of fine aggregate, coarse aggregate, portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture.
- b. Fine aggregate: hard, dense, durable, clean, and uncoated sand.
- c. Coarse aggregate: reasonably well graded from 3/16 inch to 1 inch.
- d. Fine and coarse aggregates: free from injurious amounts of dirt, vegetable matter, soft fragments or other deleterious substances.
- e. Water: fresh, clean, and free from salts, alkali, organic matter, and other impurities.
- f. Concrete associated with electrical work for other than encasement of underground ducts: 4000 psi minimum 28-day compressive strength unless specified otherwise.
- g. Slump: Less than 4 inches. Retempering of concrete will not be permitted.
- h. Exposed, unformed concrete surfaces: smooth, wood float finish.
- i. Concrete must be cured for a period of not less than 7 days, and concrete made with high early strength portland cement must be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer.

- j. Air entrain concrete exposed to weather using an air-entraining admixture conforming to **ASTM C260/C260M**.
- k. Air content: between 4 and 6 percent.

2.8 SOURCE QUALITY CONTROL

2.8.1 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.

2.8.2 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 (KNAN), 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.

2.8.3 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 4/0 AWG bare copper. Provide four ground rods in the ground ring, one per corner. Install the ground rods at least **10 feet** apart from each other. 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.

3.3.1 Meters and Current Transformers

ANSI C12.1.

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 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. Verify that the tap changer is set at the specified ratio.
- (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 Current Transformers

a. Visual and mechanical inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Verify correct connection.
- (4) Verify that adequate clearances exist between primary and secondary circuit wiring.
- (5) Verify the unit is 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 that all required grounding and shorting connections provide good contact.
- (8) Verify correct operation of transformer withdrawal mechanism and grounding operation.
- (9) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical tests

- (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
- (2) Perform insulation-resistance test.
- (3) Perform a polarity test.
- (4) Perform a ratio-verification test.

3.6.1.3 Watthour Meter

a. Visual and mechanical inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Verify tightness of electrical connections.

b. Electrical tests

- (1) Calibrate watthour meters according to manufacturer's published data.
- (2) Verify that correct multiplier has been placed on face of meter, where applicable.
- (3) Verify that current transformer secondary circuits are intact.

3.6.1.4 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.

3.6.1.5 Surge Arresters, Medium- and High-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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM

08/19, CHG 3: 11/21

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.

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 81 (2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

IEEE 100 (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1 (2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1 (2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)

ANSI C80.3 (2020) American National Standard for Electrical Metallic Tubing (EMT)

ANSI C80.5	(2020) American National Standard for Electrical Rigid Aluminum Conduit
NEMA 250	(2020) 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 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA VE 1	(2017) Metal Cable Tray Systems
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2016) Wiring Devices Dimensions Specifications
NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 70E	(2021) Standard for Electrical Safety in the Workplace
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-569	(2019e) Telecommunications Pathways and Spaces
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer

Premises

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.147 The Control of Hazardous Energy (Lock
Out/Tag Out)

29 CFR 1910.303 Electrical, General

UNDERWRITERS LABORATORIES (UL)

UL 1 (2005; Reprint Jan 2020) UL Standard for
Safety Flexible Metal Conduit

UL 6 (2007; Reprint Sep 2019) UL Standard for
Safety Electrical Rigid Metal Conduit-Steel

UL 6A (2008; Reprint Mar 2021) UL Standard for
Safety Electrical Rigid Metal Conduit -
Aluminum, Red Brass, and Stainless Steel

UL 20 (2018; Reprint Jan 2021) UL Standard for
Safety General-Use Snap Switches

UL 50 (2015) UL Standard for Safety Enclosures
for Electrical Equipment,
Non-Environmental Considerations

UL 67 (2018; Reprint Jul 2020) UL Standard for
Safety Panelboards

UL 83 (2017; Reprint Mar 2020) UL Standard for
Safety Thermoplastic-Insulated Wires and
Cables

UL 248-4 (2010; Reprint Apr 2019) Low-Voltage Fuses
- Part 4: Class CC Fuses

UL 248-8 (2011; Reprint Aug 2020) Low-Voltage Fuses
- Part 8: Class J Fuses

UL 248-10 (2011; Reprint Aug 2020) Low-Voltage Fuses
- Part 10: Class L Fuses

UL 248-12 (2011; Reprint Aug 2020) Low Voltage Fuses
- Part 12: Class R Fuses

UL 248-15 (2018) Low-Voltage Fuses - Part 15: Class
T Fuses

UL 360 (2013; Reprint Aug 2021) UL Standard for
Safety Liquid-Tight Flexible Metal Conduit

UL 467 (2022) UL Standard for Safety Grounding
and Bonding Equipment

UL 486A-486B (2018; Reprint May 2021) UL Standard for
Safety Wire Connectors

UL 486C	(2018; Reprint May 2021) UL Standard for Safety Splicing Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 498	(2017; Reprint Sep 2021) UL Standard for Safety Attachment Plugs and Receptacles
UL 510	(2020) 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 May 2020) Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 797	(2007; Reprint Mar 2021) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL 854	(2020) Standard for Service-Entrance Cables
UL 869A	(2006; Reprint Jun 2020) Reference Standard for Service Equipment
UL 943	(2016; Reprint Feb 2018) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel
UL 1449	(2021) UL Standard for Safety Surge Protective Devices
UL 1569	(2018) UL Standard for Safety Metal-Clad Cables
UL 1660	(2019) Liquid-Tight Flexible Nonmetallic Conduit
UL 1699	(2017; Reprint Feb 2022) UL Standard for Safety Arc-Fault Circuit-Interrupters
UL 4248-1	(2022) UL Standard for Safety Fuseholders - Part 1: General Requirements
UL 4248-12	(2018) UL Standard for Safety Fuseholders

- Part 12: Class R

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panelboards; G

Cable Trays; G

SD-03 Product Data

Receptacles; G

Circuit Breakers; G

Switches; G

Enclosed Circuit Breakers; G

Manual Motor Starters; G

Secondary Bonding Busbar; G

Surge Protective Devices; G

Cable Trays; G

SD-06 Test Reports

600-volt Wiring Test; G

Grounding System Test; G

Ground-fault Receptacle Test; G

Arc-fault Receptacle Test; G

SD-07 Certificates

Fuses; G

SD-10 Operation and Maintenance Data

Electrical Systems, Data Package 5; G

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, "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. NECA NEIS 1 shall be considered the minimum standard for workmanship.

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 data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein. 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, and EPC-80 in accordance with NEMA TC 2, UL 651.

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, limited to 6 feet.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360, limited to 6 feet.

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.

2.2.8 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC, 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 depth as indicated.
- 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 size as indicated with maximum wire mesh spacing of 2 by 4 inch.

2.3.2 Ladder-Type Cable Trays

Provide size as indicated with maximum rung spacing of 6 inches.

2.4 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.4.1 Outlet Boxes for Telecommunications System

Provide the following:

- a. Standard type 4 11/16 inches square 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

UL 50; volume greater than 100 cubic inches, NEMA Type 1 enclosure; sheet steel, hot-dip, zinc-coated. Where exposed to wet, damp, or corrosive environments, NEMA Type as indicated.

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.
- 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. Conductors indicated to be No. 6 AWG or smaller diameter: copper. Conductors indicated to be No. 4 AWG and larger diameter: either copper or aluminum, unless type of conductor material is specifically indicated, or specified, or required by equipment manufacturer.

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.
- e. Digital low voltage lighting control (DLVLC) system at 24 Volts or less: Category 5 UTP cables in EMT conduit.

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, 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 equipment or devices 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 750 kcmil. 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 (PBB) 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.

2.6.6 Metal-Clad Cable

UL 1569; NFPA 70, Type MC cable.

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: nylon or lexan, minimum 0.03 inch wall thickness and same color as receptacle or toggle switch with which they are mounted.
- f. Screws: machine-type with countersunk heads in color to match finish of plate.
- g. Sectional type device plates are not be permitted.
- h. 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, double 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 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 1 3R 4X Type 304 stainless steel, enclosure as indicated 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 248-12, Class RK-1 RK-5. 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 248-8, **UL 248-10**, **UL 248-4**, 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 248-15, 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**, general purpose specification grade, grounding-type. Residential grade receptacles are not acceptable.
- 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 Split Duplex Receptacles

Provide separate terminals for each ungrounded pole. One receptacle must be controlled separately.

2.11.2 Weatherproof Receptacles

Provide receptacles, UL listed for use in "wet locations" with integral GFCI protection. 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 when the current to ground is 6 milliamperes or higher, 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.

2.11.4 Dryer Receptacles

NEMA 14-30 configuration, rated 30 amperes, 125/250 volts. Furnish one matching plug with each receptacle.

2.11.5 Tamper-Resistant Receptacles

Provide duplex receptacle with mechanical sliding shutters that prevent the insertion of small objects into its contact slots.

2.11.6 Arc-Fault Circuit Interrupter Receptacles

UL 1699, duplex type for mounting in standard outlet box. Provide device capable of detecting series arcing current when the current to ground is 5 amperes or higher, and tripping per requirements of UL 1699.

2.12 PANELBOARDS

Provide panelboards in accordance with the following:

- a. UL 67 and UL 50 having a short-circuit current rating as indicated .
- 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 design drawings. If it is not possible to match "specific breaker placement" during construction, obtain Government approval prior to device installation.
- f. Use of "Subfeed Breakers" is not acceptable.
- 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).
- l. Type directories and mount in holder behind transparent protective covering.
- m. Panelboards: listed and labeled for their intended use.
- n. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.
- a. [UL 67](#) and [UL 50](#).
- b. Panelboards for use as service disconnecting: 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. Where "space only" is indicated, make provisions for future installation of breaker sized as indicated.
- f. Directories: indicate load served by each circuit of panelboard.
- g. Directories: indicate source of service (e.g. upstream panel, switchboard, motor control center) to panelboard.
- h. Type directories and mount in holder behind transparent protective covering.
- i. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

2.12.1 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 4x with conduit hubs welded to the cabinet.
- 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 latch.
- 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.

2.12.2 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.

2.12.2.1 Panelboard Neutrals for Non-Linear Loads

Provide in accordance with the following:.

- a. UL listed, with panelboard type specifically UL heat rise tested for use on non-linear loads.
- b. Panelboard: heat rise tested in accordance with **UL 67**, except with the neutral assembly installed and carrying 200 percent of the phase bus current during testing.
- c. Verification of the testing procedure: provided upon request.
- d. Two neutral assemblies paralleled together with cable is not acceptable.
- e. Nameplates for panelboard rated for use on non-linear loads: marked "SUITABLE FOR NON-LINEAR LOADS" and in accordance with paragraph FIELD FABRICATED NAMEPLATES.

- f. Provide a neutral label with instructions for wiring the neutral of panelboards rated for use on non-linear loads.

2.12.3 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. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

2.12.3.1 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.

2.12.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with auto-monitoring (self-test) and lockout features, "push-to-test" button, visible indication of tripped condition, and ability to detect and trip when current imbalance is 6 milliamperes or higher per requirements of UL 943 for Class A ground-fault circuit interrupter devices.

2.12.3.3 Arc-Fault Circuit Interrupters

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated. Provide with "push-to-test" button.

2.13 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated.

2.14 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

Single pole designed for surface mounting with overload protection.

2.15 LOCKOUT REQUIREMENTS

Provide circuit breakers, disconnecting means, and other devices that are electrical energy-isolating 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, NFPA 70E and 29 CFR 1910.303. Comply with requirements of Division 23, "Mechanical" for mechanical isolation of machines and other equipment.

2.16 TELECOMMUNICATIONS SYSTEM

Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires cable trays, and other accessories for telecommunications outlets and pathway in accordance with TIA-569 and as specified herein. Additional telecommunications requirements are specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS

CABLING SYSTEM.

2.17 GROUNDING AND BONDING EQUIPMENT

2.17.1 Ground Rods

UL 467. Ground rods: cone pointed copper-clad steel, with minimum diameter of 3/4 inch and minimum length 10 feet. Sectional type rods may be used for rods 20 feet or longer.

2.17.2 Secondary Bonding Busbar

Provide corrosion-resistant grounding busbar suitable for indoor installation in accordance with TIA-607. Busbars: 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 Primary bonding busbar (PBB) in the telecommunications entrance facility and a Secondary bonding busbar (SBB) in all other telecommunications rooms and equipment rooms. The Primary bonding busbar (PBB) and the Secondary bonding busbar (SBB): sized in accordance with the immediate application requirements and with consideration of future growth. Provide Secondary bonding busbars with the following:

- a. Predrilled copper busbar provided with holes for use with standard sized lugs,
- b. Minimum dimensions of 0.25 in thick by 4 in wide for the PBB and 2 in wide for SBBs with length as indicated;
- c. Listed by a nationally recognized testing laboratory.

2.18 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.

2.19 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.
- f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.
- g. Minimum size of nameplates: one by 2.5 inches.

- h. Lettering size and style: a minimum of 0.25 inch high normal block style.

2.20 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers 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.

2.21 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00 FIRESTOPPING.

2.22 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service entrance , panelboards . Provide surge protectors in a NEMA 1 enclosure per NEMA ICS 6. SPD must have the same short-circuit current rating as the protected equipment and must not be installed at a point of system where the available fault current is in excess of that rating. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker. Submit performance and characteristic curves.

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).

Provide SPDs per NFPA 780 for the lightning protection system.

Maximum L-N, and N-G Voltage Protection Rating:

600V for 208Y/120V, three phase system

Maximum L-G Protection Rating:

700V for 208Y/120V, three phase system

Maximum L-L Voltage Protection Rating:

1,200V for 208Y/120V, three phase system

The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120 percent of nominal voltage for 240 volts and below; 115 percent of nominal voltage above 240 volts to 480 volts.

2.23 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.

2.24 COORDINATED POWER SYSTEM PROTECTION

Prepare analyses as specified in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION.

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 to requirements specified herein.

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.

3.1.1.3 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. Shared neutral, or multi-wire branch circuits, are not permitted with arc-fault circuit interrupters. Minimum conduit size: 1/2 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.

3.1.3.2 Metal-Clad Cable

Install in accordance with NFPA 70, Type MC cable.

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 conduits under floor slab as if exposed.

3.1.4.1 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 physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.
- d. Do not use in hazardous areas.

- e. Do not use outdoors.
- f. Do not use in fire pump rooms.
- g. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.2 Restrictions Applicable to Nonmetallic Conduit

- a. PVC Schedule 40.
 - (1) Do not use where subject to physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, fire pump rooms, and where restrictions are applying to both PVC Schedule 40 and PVC Schedule 80.
 - (2) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.
- b. PVC Schedule 40 and Schedule 80.
 - (1) Do not use where subject to physical damage, including but not limited to, hospitals, power plant, missile magazines, and other such areas.
 - (2) Do not use in hazardous (classified) areas.
 - (3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

-

3.1.4.3 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.4 Underground Conduit

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40
Plastic coating: extend minimum 6 inches above floor.

3.1.4.5 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. Use NECA NEIS 1 Table 2a (Minimum Raceway Spacing) to determine under floor slab conduit spacing unless greater spacing is required elsewhere in this section.

3.1.4.6 Conduit Through Floor Slabs

Where conduits rise through floor slabs, do not allow curved portion of bends to be visible above finished slab. Where conduit rises through slab-on grade, seal all electrical penetrations to address radon mitigation and prevent infiltration of air, insects, and vermin.

3.1.4.7 Conduit Installed in Concrete Floor Slabs

Rigid steel; steel IMC; fiberglass, or PVC, Type EPC-40. Locate so as not

to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab. Do not stack conduits. Space conduits horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends must not be visible above finish slab. Increase slab thickness as necessary to provide minimum [one inch](#) cover over conduit. Where embedded conduits cross building expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings must allow horizontal and vertical movement of raceway. Conduit larger than [one inch](#) trade size: installed parallel with or at right angles to main reinforcement; when at right angles to reinforcement, install conduit close to one of supports of slab. Where nonmetallic conduit is used, convert raceway to plastic coated rigid steel or plastic coated steel IMC before rising above floor, unless specifically indicated.

3.1.4.8 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 inches](#) above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.4.9 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Plastic cable ties are not acceptable. 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. 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.

3.1.4.10 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.

3.1.4.11 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.

3.1.4.12 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semirecessed 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: 1/2 inch diameter. Provide liquid tight flexible nonmetallic conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections. Plastic cable ties are not acceptable as a support method.

3.1.4.13 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-568.1. Size conduits, 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, and cable trays for telecommunications risers in accordance with TIA-569 and as indicated.

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. Cable tray and tray supports must not partially nor completely obstruct access to the room. 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. 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, 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.

3.1.7 Mounting Heights

Mount panelboards, enclosed circuit breakers, and disconnecting switches so height of center of grip of the operating handle of the switch or circuit breaker at its highest position is maximum 79 inches above floor or working platform or as allowed in Section 404.8 per NFPA 70. 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. Identify control circuit terminations in accordance with manufacturer's recommendations. 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 for identification of power distribution, control, data, and communications cables 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.

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 at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70.

Make ground connection to driven ground rods on exterior of building. Bond additional driven rods together with a minimum of 4 AWG soft bare copper wire buried to a depth of at least 12 inches. 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 ground rods and 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, additional rods, spaced on center. Spacing for additional rods must be a minimum of 10 feet. 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 high 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 high compression connections using a hydraulic or electric 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 Primary bonding busbar (PBB) in the telecommunications entrance facility. Install the PBB as close to the electrical service entrance grounding connection as practicable. Provide a Secondary bonding busbar (SBB) in all other telecommunications rooms and telecommunications equipment rooms. Install the SBB 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 SBB near the backbone cabling and associated terminations. In addition, locate the SBB 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 SBB, bond that panelboard's alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure to the SBB. Install Secondary bonding 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 PBB 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 PBB extends throughout the building using the telecommunications backbone pathways, and connects

to the SBBs 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 SBB 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 PBB or the SBB.

- c. Telecommunications Grounding Connections: Telecommunications grounding connections to the PBB or SBB: 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 PBB or SBB to the PBB or SBB respectively. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; bond each PBB and SBB 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 SBB or PBB 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 SBB 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 avoiding 90 degree bends. Do not

locate surge protective devices inside a panelboard or switchboard enclosure.

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.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 5 working days notice prior to each test. Where applicable, test electrical equipment in accordance with NETA ATS.

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 1,000 volts DC for 600 volt rated wiring and 500 volts DC for 300 volt rated wiring per NETA ATS to provide direct reading of resistance. All existing wiring to be reused must also be tested.

3.5.3 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. Press the TEST button and then the RESET button to verify by LED status that the device is a self-test model as specified in UL 943.

3.5.4 Arc-Fault Receptacle Test

Test arc-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed. Press the TEST button and then the RESET button to verify by LED status that the device is a self-test model as specified in UL 1699.

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.

3.5.7 Phase Rotation Test

Perform phase rotation test to ensure proper rotation of service power prior to operation of new or reinstalled equipment using a phase rotation meter. Follow the meter manual directions performing the test.

-- End of Section --

SECTION 26 24 13

SWITCHBOARDS

08/21

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.

ASTM INTERNATIONAL (ASTM)

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 A653/A653M	(2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

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
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
----------	--

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA PB 2.1	(2013) General Instructions for Proper Handling, Installation, Operation and
------------------	--

Maintenance of Deadfront Distribution
Switchboards Rated 600 V or Less

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA PB 2	(2011) Deadfront Distribution Switchboards
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(2023) National Electrical Code
UNDERWRITERS LABORATORIES (UL)	
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 891	(2019) UL Standard for Safety Switchboards

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 100.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchboard Drawings; G

SD-03 Product Data

Switchboard; G

SD-06 Test Reports

Switchboard Design Tests; G

Switchboard Production Tests; G

Acceptance Checks and Tests; G

SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5; G

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G

Equipment Test Schedule; G

Required Settings; G

Service Entrance Available Fault Current Label; G

1.5 QUALITY ASSURANCE

1.5.1 Product Data

Include manufacturer's information on each submittal for each component, device and accessory provided with the switchboard including:

- a. Circuit breaker type, interrupting rating, and trip devices, including available settings.
- b. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device.

1.5.2 Switchboard 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. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity on submittal. Also include applicable federal, military, industry, and technical society publication references on submittals. Include the following:

- a. One-line diagram including breakers.
- b. Outline drawings including front elevation, section views, footprint, and overall dimensions.
- c. Bus configuration including dimensions and ampere ratings of bus bars.
- d. Markings and NEMA nameplate data.
- e. Circuit breaker type, interrupting rating, and trip devices, including available settings.
- f. Wiring diagrams and elementary diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.
- g. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device. Use this information (designer of record) to

provide breaker settings that ensures protection and coordination are achieved. For Navy installations, provide electronic format curves using SKM's Power Tools for Windows device library electronic format or EasyPower device library format depending on installation modeling software requirements.

1.5.3 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.

1.5.4 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.

1.5.4.1 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 furnished.

1.5.4.2 Material and Equipment Manufacturing Date

Products manufactured more than one year prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

1.6.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.2 Assembled Operation and Maintenance Manuals

Assemble and securely bind manuals in durable, hard covered, water resistant binders. Assemble and index the manuals in the following order with a table of contents:

- a. Manufacturer's O&M information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA.
- b. Catalog data required by the paragraph SD-03, PRODUCT DATA.
- c. Drawings required by the paragraph SD-02, SHOP DRAWINGS.
- d. Prices for spare parts and supply list.
- f. Design test reports.
- g. Production test reports.

1.7 WARRANTY

Provide equipment items that are supported by service organizations 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 PRODUCT COORDINATION

Products and materials not considered to be switchboards and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SWITCHBOARD

NEMA PB 2 and UL 891.

2.2.1 Ratings

Provide equipment with the following ratings:

- a. Voltage rating: 208Y/120 volts AC, three-phase, 4-wire as indicated.
- b. Continuous current rating of the main bus: as indicated.
- c. Short-circuit current rating: as indicated.
- d. UL listed and labeled as service entrance equipment.

2.2.2 Construction

Provide the following:

- a. Switchboard: consisting of one or more vertical sections bolted together to form a rigid assembly and rearfront and rear aligned.
- b. All circuit breakers: front accessible.
- c. Rear aligned switchboards: front accessible load connections.
- d. Front and rear aligned switchboards: rear accessible load connections.
- e. Where indicated, "space for future" or "space" means to include a

vertical bus provided behind a blank front cover. Where indicated, "provision for future" means full hardware provided to mount a breaker suitable for the location.

- f. Completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

2.2.2.1 Enclosure

Provide the following:

- a. Enclosure: **NEMA ICS 6** Type 1.
- b. Enclosure: bolted together with removable bolt-on side and rear covers.
- c. Front doors: provided with padlockable vault handles with a three point catch.
- d. Bases, frames and channels of enclosure: corrosion resistant and fabricated of galvanized steel. Separate sections using vertical steel barriers.
- e. Base: includes any part of enclosure that is within **3 inches** of concrete pad.
- f. Galvanized steel: **ASTM A123/A123M**, **ASTM A653/A653M** G90 coating, and **ASTM A153/A153M**, as applicable. Galvanize after fabrication where practicable.
- g. Paint color: **ASTM D1535** light gray No. 61 or No. 49 over rust inhibitor.
- h. Paint coating system: comply with **IEEE C57.12.28** for galvanized steel.

2.2.2.2 Bus Bars

Provide the following:

- a. Bus bars: copper with silver-plated contact surfaces.
 - (1) Phase bus bars: uninsulated.
 - (2) Neutral bus: rated 100 percent of the main bus continuous current rating as indicated.
- b. Make bus connections and joints with hardened steel bolts.
- c. Main-bus (through bus): rated at the full ampacity of the main throughout the switchboard.
- d. Minimum **one-quarter by 2 inch** copper ground bus secured to each vertical section along the entire length of the switchboard.

2.2.2.3 Main Section

Provide the main section consisting of a combination section with molded-case circuit breakers for the main and branch devices as indicated.

2.2.2.4 Distribution Sections

Provide the distribution sections consisting of molded-case circuit breakers as indicated.

2.2.3 Protective Device

Provide main and branch protective devices as indicated.

2.2.3.1 Insulated-Case Breaker

Provide the following:

- a. **UL 489**. UL listed and labeled, 100 percent rated main breaker standard rated branch breakers, manually operated, low voltage, insulated-case circuit breaker, with a short-circuit current rating as indicated
- b. Breaker frame size: as indicated.
- c. Series rated circuit breakers are unacceptable.

2.2.3.2 Molded-Case Circuit Breaker

Provide the following:

- a. **UL 489**. UL listed and labeled, 100 percent rated main breaker standard rated branch breakers, manually operated, low voltage molded-case circuit breaker, with a short-circuit current rating of as indicated
- b. Breaker frame size: as indicated.
- c. Series rated circuit breakers are unacceptable.

2.2.4 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Provide short-circuiting type terminal boards associated with current transformer. Terminate conductors for current transformers with ring-tongue lugs. Provide terminal board identification that is identical in similar units. Provide color coded external wiring that is color coded consistently for similar terminal boards.

2.2.5 Wire Marking

Mark control and metering conductors at each end. Provide factory installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Provide a single letter or number on each sleeve, elliptically shaped to securely grip the wire, and keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Indicate on each wire marker the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.3 MANUFACTURER'S NAMEPLATE

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.4 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each switchboard, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Identify on each nameplate inscription the function and, when applicable, the position. Provide nameplates of melamine plastic, **0.125 inch** thick, white with black center core. Provide matte finish surface. Provide square corners. Accurately align lettering and engrave into the core. Provide nameplates with minimum size of **one by 2.5 inches**. Provide lettering that is a minimum of **0.25 inch** high normal block style.

2.5 SOURCE QUALITY CONTROL

2.5.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules 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.

Provide the following as part of test equipment calibration:

- a. Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
- b. Accuracy: Traceable to the National Institute of Standards and Technology.
- c. Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.
- d. Dated calibration labels: visible on all test equipment.
- e. Calibrating standard: higher accuracy than that of the instrument tested.
- f. 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:
 - (1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.
 - (2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.5.2 Switchboard Design Tests

NEMA PB 2 and UL 891.

2.5.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

- a. Short-circuit current test.
- b. Enclosure tests.
- c. Dielectric test.

2.5.3 Switchboard Production Tests

NEMA PB 2 and UL 891. Furnish reports which include results of production tests performed on the actual equipment for this project. These tests include:

- a. 60-hertz dielectric tests.
- b. Mechanical operation tests.
- c. Electrical operation and control wiring tests.
- d. Ground fault sensing equipment test.

2.6 COORDINATED POWER SYSTEM PROTECTION

Provide a power system study as specified in Section 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION.

2.7 ARC FLASH WARNING LABEL

Provide warning label for switchboards. Locate this self-adhesive warning label on the outside of the enclosure warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

2.8 SERVICE ENTRANCE AVAILABLE FAULT CURRENT LABEL

Provide label on exterior of switchboards used as service equipment listing the maximum available fault current at that location. Include on the label the date that the fault calculation was performed and the contact information for the organization that completed the calculation. Locate this self-adhesive warning label on the outside of the switchboard. Provide label format as indicated.

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 that grounds and 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 the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 24 inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed 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 equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Switchboard

ANSI/NEMA PB 2.1.

3.3.2 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.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.4.1 Interior Location

Mount switchboard on concrete slab as follows:

- a. Unless otherwise indicated, provide the slab with dimensions at least 4 inches thick.
- b. Install slab such that the top of the concrete slab is approximately 4 inches above the finished grade.
- c. Provide edges above grade 1/2 inch chamfer.

- d. Provide slab of adequate size to project at least 8 inches beyond the equipment.
- e. Provide conduit turnups and cable entrance space required by the equipment to be mounted.
- f. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant.
- g. Cut off and bush conduits 3 inches above slab surface.
- h. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

Submit Required Settings of breakers to the Contracting Officer after approval of switchboard and at least 30 days in advance of their requirement.

3.5.1 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.

3.5.1.1 Switchboard Assemblies

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical, electrical, and mechanical condition.
- (3) Verify appropriate anchorage, required area clearances, and correct alignment.
- (4) Clean switchboard and verify shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
- (5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
- (6) Verify that circuit breaker sizes and types correspond to approved shop drawings as well as to the circuit breaker's address for microprocessor-communication packages.
- (8) 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.
- (9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
- (10) Confirm correct application of manufacturer's recommended lubricants.

- (11) Inspect insulators for evidence of physical damage or contaminated surfaces.
- (12) Verify correct barrier installation.
- (13) Exercise all active components.
- (14) Inspect all mechanical indicating devices for correct operation.
- (15) Verify that filters are in place and vents are clear.
- (16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.
- (17) Inspect control power transformers.

b. Electrical Tests

- (1) Perform insulation-resistance tests on each bus section.
- (2) Perform dielectric withstand voltage tests.
- (3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.
- (4) Perform control wiring performance test.
- (5) Perform primary current injection tests on the entire current circuit in each section of assembly.

3.5.1.2 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Inspect anchorage, alignment, and grounding.
- (4) Verify that all maintenance devices are available for servicing and operating the breaker.
- (5) Inspect arc chutes.
- (6) Inspect moving and stationary contacts for condition, wear, and alignment.
- (7) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
- (8) Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.
- (9) 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.

- (10) Verify cell fit and element alignment.
- (11) Verify racking mechanism.
- (12) Confirm correct application of manufacturer's recommended lubricants.

b. Electrical Tests

- (1) Perform contact-resistance tests on each breaker.
- (2) Perform insulation-resistance tests.
- (3) Adjust Breaker(s) for final settings in accordance with Government provided settings.
- (4) Determine long-time minimum pickup current by primary current injection.
- (5) Determine long-time delay by primary current injection.
- (10) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.
- (11) Verify operation of charging mechanism.

3.5.1.3 Circuit Breakers

Low Voltage - Insulated-Case and Low Voltage Molded Case with Solid State Trips

a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.
- (2) Inspect circuit breaker for correct mounting.
- (3) Operate circuit breaker to ensure smooth operation.
- (4) Inspect case for cracks or other defects.
- (5) Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.
- (6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

- (1) Perform contact-resistance tests.
- (2) Perform insulation-resistance tests.

- (3) Perform Breaker adjustments for final settings in accordance with Government provided settings.
- (4) Perform long-time delay time-current characteristic tests

3.5.1.4 Current Transformers

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Verify correct connection.
- (4) Verify that adequate clearances exist between primary and secondary circuit.
- (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 all required grounding and shorting connections provide good contact.

b. Electrical Tests

- (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
- (2) Perform insulation-resistance tests.
- (3) Perform polarity tests.
- (4) Perform ratio-verification tests.

3.5.1.5 Metering and Instrumentation

a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Verify tightness of electrical connections.

b. Electrical Tests

- (1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.
- (2) Calibrate watthour meters according to manufacturer's published data.
- (3) Verify all instrument multipliers.

- (4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.5.1.6 Grounding System

a. Visual and Mechanical Inspection

- (1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

- (1) **IEEE 81**. 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.

3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Trip circuit breakers by operation of each protective device. Test each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, provide the Contracting Officer five working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 27 14.00 20

ELECTRICITY METERING
02/21, CHG 1: 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 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

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP (2019; Errata 1 2019; Errata 2-5 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 6-8 2021; Interpretation 1-4 2020; Interpretation 5-8 2021 Addenda AS-AQ 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE 90.1 - SI (2019; Errata 1-4 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 5-7 2021; Interpretation 1-4 2020; Interpretation 5-8 2021; Addenda AU-CM 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

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) Standard Requirements for Instrument Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.7 (2014) Requirements for Watthour Meter Sockets

ANSI C12.18	(2006; R 2016) Protocol Specification for ANSI Type 2 Optical Port
ANSI C12.20	(2015; E 2018) Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes
NEMA C12.19	(2021) Utility Industry End Device Data Tables

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
---------	---------------------------------

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Electricity Meters; G

Current Transformer; G

Potential Transformer; G

External Communications Devices; G

SD-06 Test Reports

Acceptance Checks and Tests; G

System Functional Verification; G

Building Meter Installation Sheet, per Building; G

Meter Configuration Template; G

Contractor must fill in the meter configuration template and submit to the Activity for concurrence.

Meter Configuration Report; G

The meter configuration report must be submitted as a Technical Data Package.

SD-10 Operation and Maintenance Data

Electricity Meters and Accessories, Data Package 5; G

Submit operation and maintenance data in accordance with Section 01 78 23
OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

System Functional Verification; G

1.3 QUALITY ASSURANCE

1.3.1 Installation Drawings

Drawings must be provided in hard-copy and electronic format, and must include but not be limited to the following:

- a. Wiring diagrams with terminals identified of advanced meter, current transformers, potential transformers, protocol modules, communications interfaces, Ethernet connections, telephone lines. For each typical meter installation, provide a diagram.
- b. One-line diagram, including meters, switch(es), current transformers, potential transformers, protocol modules, communications interfaces, Ethernet connections, telephone outlets, and fuses. For each typical meter installation, provide a diagram. Provide one-line diagram to the local Public Works department.

1.3.2 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 must have been in satisfactory commercial or industrial use for one year prior to bid opening. The one-year period must include applications of equipment and materials under similar circumstances and of similar size. The product, or an earlier release of the product, must have been on sale on the commercial market through advertisements, manufacturers catalogs, or brochures during the prior one-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.

1.3.3 Material and Equipment Manufacturing Data

Products manufactured more than 1 year prior to date of delivery to site must not be used, unless specified otherwise.

1.4 MAINTENANCE

1.4.1 Additions to Operation and Maintenance Data

In addition to requirements of Data Package 5, include the following on the actual [electricity meters and accessories](#) provided:

- a. A condensed description of how the system operates
- b. Block diagram indicating major assemblies
- c. Troubleshooting information

- d. Preventive maintenance
- e. Prices for spare parts and supply list

1.5 WARRANTY

The equipment items and software must be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment and software on a regular and emergency basis during the warranty period of the contract.

1.6 SYSTEM DESCRIPTION

1.6.1 System Requirements

Electricity metering, consisting of meters and associated equipment, will be used to record the electricity consumption and other values as described in the requirements that follow and as shown on the drawings. Communication system requirements are contained in a separate specification section as identified in paragraph COMMUNICATIONS INTERFACES.

1.6.2 Selection Criteria

Metering components and software are part of a system that includes the physical meter, data recorder function and communications method. Every building site identified must include sufficient metering components to measure the electrical parameters identified and to store and communicate the values as required.

Contractor must verify that the electricity meter installed on any building site is compatible with the base-wide metering system with respect to the types of meters selected and the method used to program the meters for initial use. Software and meter programming tools are necessary to set up the meters described by this specification. New software tools different from the meter programming methods currently used by base personnel will require an Authority to Operate (ATO) by Command Information Office at the Enterprise level..

PART 2 PRODUCTS

2.1 ELECTRICITY METERS AND ACCESSORIES

Provide meter(s) and connect the meter(s) to the existing AMI DAS. The contractor must use the existing government laptop computers to configure the meter using existing software loaded on the computer. The contractor will not be allowed to modify any software or add any additional software to the computer. Alternatively, the government will configure the meter(s), which must be compatible with the existing system, using existing software. Contractor must insure that the meter(s) will transmit the specified data to the DAS. The current meters being used by base are: **Coordiante with contracting officer..**

2.1.1 Physical and Common Requirements

- a. Provide metering system components in accordance with the Metering System Schedule shown in this specification. Provide **Meter configuration template.**

- b.
- c. Meter must have NEMA 3R stainless steel enclosure for surface mounting with bottom or rear penetrations.
- d. Surge withstand capability must conform to [IEEE C37.90.1](#).
- e. Use #12 SIS (XHHW, or equivalent) wiring with ring lugs for all meter connections. Color code and mark the conductors as follows:
 - (1) Red - Phase A CT - C1
 - (2) Orange - Phase B CT - C2
 - (3) Brown - Phase C CT - C3
 - (4) Gray with white stripe - neutral current return - C0
 - (5) Black - Phase A voltage - V1
 - (6) Yellow - Phase B voltage - V2
 - (7) Blue - Phase C voltage - V3
 - (8) White - Neutral voltage

2.1.1.2 [Potential Transformer](#) Requirements

- a. Meter must be capable of connection to the service voltage phases and magnitude being monitored. If the meter is not rated for the service voltage, provide suitable potential transformers to send an acceptable voltage to the meter.
- b. Voltage input must be optically isolated to 2500 volts DC from signal and communications outputs. Components must meet or exceed [IEEE C37.90.1](#).
- c. Provide a pull-out type fuse block containing one fuse per phase, Class RK type, to protect the voltage input to the meter. Size fuses as recommended by the meter manufacturer. Fusing must either be inside the secondary compartment of the transformer or inside the same enclosure as the CT shorting device.
- d. Potential transformers will be used to convert 480 volt inputs to 120 volts for the locations shown on the metering schedule. Potential transformers must be rated indoor or outdoor, as required for the specific application. Voltage rating must provide 120 volts, wye-connected, 3 phase, 4 wire, 60 Hz, insulation class, 600 volts. Potential transformers BIL must be 10 kV and must have an accuracy class of 0.3 at burdens w, x, and y. Thermal rating must be 500 VA.
- e. The Contractor must be responsible for determining the actual voltage ratio of each potential transformer for medium voltage applications. Transformer must conform to [IEEE C57.13](#) and the following requirements.
 - (1) Type: Dry type, of two-winding construction.
 - (2) Weather: Outdoor or indoor rated for the application.
 - (3) Frequency: Nominal 60 Hz.
 - (4) Accuracy: Plus or minus 0.3 percent at 60 Hz.
- f. Potential transformers installed inside switchgear and panels must be rated for interior use. Voltage rating must provide 120 volts, wye-connected, 3 phase, 4 wire, 60 Hz, insulation class, 600 volts.

Potential transformers BIL must be a minimum of 10 kV, and have an insulation class and BIL rating that equals or exceeds the ratings of the associated switchgear. Potential transformers must have an accuracy class of 0.15 at burdens w, x, and y. Thermal rating must be 500 VA. Potential transformers must be accessed from the front and mounted in a metering section.

2.1.1.3 Current Transformer Requirements

- a. Current transformer must be installed with a rating as shown in the schedule.
- b. Current transformers must have an Accuracy Class of 0.15 (with a maximum error of plus/minus 0.3 percent at 5.0 amperes) when operating within the specified rating factor.
- c. Current transformers must be solid-core, bracket-mounted for new installations using ring-tongue lugs for electrical connections. Current transformers must be accessible and the associated wiring must be installed in an organized and neat workmanship arrangement. Current transformers that are retrofitted onto existing switchgear busbar can be a busbar split-core design.
- d. Current transformers must have:
 - (1) Insulation Class: All 600 volt and below current transformers must be rated 10 KV BIL.
 - (2) Frequency: Nominal 60 Hz.
 - (3) Burden: Burden class must be selected for the load.
 - (4) Phase Angle Range: 0 to 60 degrees.
- e. Meter must accept current input from standard instrument transformers (5A secondary current transformers).
- f. Current inputs must have a continuous rating in accordance with [IEEE C57.13](#).
- g. Provide one single-ratio current transformer for each phase per power transformer with characteristics listed in the following table.

Single-Ratio Current Transformer Characteristics				
kVA	Sec. Volt	CT Ratio	RF	Meter Acc. Class
500	208Y:120	1200:5	1.33	0.3 thru B0.05
750	480Y:277	800/5	1.33	0.3 thru B0.05

2.1.1.4 Meter Requirements

[Electricity meters](#) must include the following features:

- a. Meter must comply with [ANSI C12.1](#), [NEMA C12.19](#), and [ANSI C12.20](#) and must match existing AMI meter system at the installation and be the

newest version with ATO.

- b. Meter sockets must comply with ANSI C12.7.
- e. Provide socket-mounted or panel mounted meters as indicated on the meter schedule.
- f. Meter must be a Class 20, transformer rated design.
- g. Use Class 200 meters for direct current reading without current transformers for applications with an expected load less than 200 amperes, where indicated.
- h. Meter must be rated for use at temperature from minus 40 degrees Centigrade to plus 70 degrees Centigrade.
- i. The meters must have an electronic demand recording register and must be secondary reading as indicated. The register must be used to indicate maximum kilowatt demand as well as cumulative or continuously cumulative demand. Demand must be measured on a block-interval basis and must be capable of a 5 to 60 minute interval and initially set to a 15-minute interval. It must have provisions to be programmed to calculate demand on a rolling interval basis. Meter readings must be true RMS.
- j. The meter electronic register must be of modular design with non-volatile data storage. Downloading meter stored data must be capable via an optical port. Recording capability of data storage with a minimum capability of 89 days of 15 minute, 2 channel interval data. The meter must be capable of providing at least 2 KYZ pulse outputs (dry contacts). Default initial configuration (unless identified otherwise by base personnel) must meet NAVFAC CIRCUITS Call for Consistency document located on the NAVFAC CIRCUITS Portal and must be:
 - (1) First channel - kWh
 - (2) Second channel - kVARh
 - (3) KYZ output #1 - kWh
 - (4) KYZ output #2 - kVARh
- k. All meters must have identical features available in accordance with this specification. The meter schedule identifies which features must be activated at each meter location.
- l. Enable switches for Time of Use (TOU), pulse and load profile measurement module at the factory.
- m. Meter must have an optical port on front of meter. Optical device must be compatible with ANSI C12.18.
- n. Meters must be 120-480 volts auto ranging.
- o. Provide blank tag fixed to the meter faceplate for the addition of the meter multiplier, which will be the product of the current transformer and potential transformer ratio and will be filled in by base personnel on the job site. The meter's nameplate must include:
 - (1) Meter ID number.

- (2) Rated voltage.
 - (3) Current class.
 - (4) Metering form.
 - (5) Test amperes.
 - (6) Frequency.
 - (7) Catalog number.
 - (8) Manufacturing date.
- p. On switchboard style installations, provide switchboard case with disconnect means for meter removal incorporating short-circuiting of current transformer circuits.
- q. Meter covers must be polycarbonate resins with an optical port and reset. Backup battery must be easily accessible for change-out after removing the meter cover.
- r. The normal billing data scroll must be fully programmable. The normal billing data scroll requirements provided in the CIRCUITS Call for Consistency Document located on the NAVFAC CIRCUITS Portal. Data scroll display must include the following.
- (1) Number of demand resets.
 - (2) End-of-interval indication.
 - (3) Maximum demand.
 - (4) New maximum demand indication.
 - (5) Cumulative or continuously cumulative.
 - (6) Time remaining in interval.
 - (7) Kilowatt hours.
- s. The register must incorporate a built-in test mode that allows it to be tested without the loss of any data or parameters. The following quantities must be available for display in the test mode:
- (1) Present interval's accumulating demand.
 - (2) Maximum demand.
 - (3) Number of impulses being received by the register.
- t. Pulse module simple I/O board with programmable ratio selection.
- u. Meters must be programmed after installation via an optical port. Optical display must show TOU data, peak kWh, semi-peak kWh, off peak kWh, and phase angles.
- v. Self-monitoring to provide for:
- (1) Unprogrammed register.
 - (2) RAM checksum error.
 - (3) ROM checksum error.
 - (4) Hardware failure.
 - (5) Memory failure.
 - (6) EPROM error.
 - (7) Battery status (fault, condition, or time in service).
- w. Liquid crystal alphanumeric displays, 9 digits, blinking squares confirm register operation. Six Large digits for data and smaller digits for display identifier.
- x. Display operations, programmable sequence with display identifiers. Display identifiers must be selectable for each item. Continually

sequence with time selectable for each item.

- y. The meters must support three modes of registers: Normal Mode, Alternate Mode, and Test Mode. The meter also must support a "Toolbox" or "Service Information" (accessible in the field) through an optocom port to a separate computer using the supplied software to allow access to instantaneous service information such as voltage, current, power factor, load demand, and the phase angle for individual phases.
- z. Meter must have a standard 4 -year warranty.

2.1.5 Disconnect Method

- a. Provide a 10-pole safety disconnect complete with isolation devices for the voltage and current transformer inputs, including a shorting means for the current transformers.
- b. Disconnecting wiring blocks must be provided between the current transformer and the meter. A shorting mechanism must be built into the wiring block to allow the current transformer wiring to be changed without removing power to the transformer. The wiring blocks must be located where they are accessible without the necessity of disconnecting power to the transformer.
- c. Voltage monitoring circuits must be equipped with disconnect switches to isolate the meter base or socket from the voltage source.

2.1.6 Installation Methods

- a. Transformer Mounted ("XFMR" in Metering Systems Schedule). Meter base must be located outside on the secondary side of the pad-mounted transformer.
- b. Stand Mounted Adjacent to Transformer ("STAND" in Metering Systems Schedule). Meter base must be mounted on a structural steel pole approximately 4 feet from the transformer pad. This can be used for multiple meters associated with a single transformers.
- c. Building Mounted ("BLDG" in Metering Systems Schedule). Meter base must be mounted on the side of the existing building near the service entrance.
- d. Panel Mounted. ("PNL" in Metering Systems Schedule). Meter must be mounted where directed.
- e. Commercial meter pedestal ("PED" in Metering Systems Schedule).

2.2 COMMUNICATIONS INTERFACES

Meter must have two-way communication with the existing data acquisition system (DAS). Provide a communications interface utilizing base standards.

Provide interfacing software if a meter is used that is different than the existing meters at the Activity to ensure compatibility within the metering system.

Connect to the AMI network utilizing base standards.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to [ASHRAE 90.1 - IP](#), [ASHRAE 90.1 - SI](#), [IEEE C2](#), [NFPA 70](#) (National Electrical Code), and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.1.1 Scheduling of Work and Outages

The Contract Clauses must govern regarding permission for power outages, scheduling of work, coordination with Government personnel, and special working conditions.

3.2 FIELD QUALITY CONTROL

Perform the following acceptance checks and tests on all installed meters.

3.2.1 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](#).

a. Meter Assembly

(1) Visual and mechanical inspection.

(a) Compare equipment nameplate data with specifications and approved shop drawings.

(b) Inspect physical and mechanical condition. Confirm the meter is firmly seated in the socket, the socket is not abnormally heated, the display is visible, and the ring and seal on the cover are intact.

(c) Inspect all electrical connections to ensure they are tight. For Class 200 services, verify tightness of the service conductor terminations for high resistance using low-resistance ohmmeter, or by verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

(d) Record model number, serial number, firmware revision, software revision, and rated control voltage.

(e) Verify operation of display and indicating devices.

(f) Record password and user log-in for each meter.

(g) Verify grounding of metering enclosure.

(h) Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements. Verify that the CT ratio and the PT ratio are properly included in the meter multiplier or the programming of the meter. Confirm that the multiplier is provided on the meter face or on the meter.

(i) Provide [building meter installation sheet, per building](#) for each facility. See example Graphic E-S1.

(2) Electrical tests.

(a) Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.

(b) Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital, and analog.

(c) After initial system energization, confirm measurements and indications are consistent with loads present.

(d) Make note of, and report, any "Error-Code" or "Caution-Code" on the meter's display.

(3) Provide [meter configuration report](#).

b. Current Transformers

(1) Visual and mechanical inspection.

(a) Compare equipment nameplate data with specification and approved shop drawings.

(b) Inspect physical and mechanical condition.

(c) Verify correct connection, including polarity.

(d) Inspect all electrical connections to ensure they are tight.

(e) Verify that required grounding and shorting connections provide good contact.

(2) Electrical Tests.

Verify proper operation by reviewing the meter configuration report.

c. Potential Transformers

(1) Visual and mechanical inspection.

(a) Verify potential transformers are rigidly mounted.

(b) Verify potential transformers are the correct voltage.

(c) Verify that adequate clearances exist between the primary and secondary circuit.

(2) Electrical Tests.

(a) Verify by the meter configuration report that the polarity and phasing are correct.

3.2.2 System Functional Verification

Verify that the installed meters are working correctly in accordance with the meter configuration report:

- a. The correct meter form is installed.
- b. All voltage phases are present.
- c. Phase rotation is correct.
- d. Phase angles are correct.
- e. The new meter accurately measures power magnitude and direction, and can communicate as required by paragraph COMMUNICATIONS INTERFACES.

-- End of Section --

SECTION 26 28 01.00 10

COORDINATED POWER SYSTEM PROTECTION
08/21

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.

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

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 Contractor Quality Control approval. Submit the following in accordance with Section **01 33 00** SUBMITTAL PROCEDURES:

SD-03 Product Data

Fault Current Analysis

Protective Device Coordination Study

System Coordinator

1.3 QUALITY ASSURANCE

1.3.1 **System Coordinator**

System coordination, recommended ratings and settings of protective devices, and design analysis must be accomplished by a registered professional electrical power engineer with a minimum of 3 years of current experience in the coordination of electrical power systems. Submit verification of experience and license number, of a registered Professional Engineer as specified above. Provide experience data consisting of at least five references for work of a magnitude comparable to this contract, including points of contact, addresses and telephone numbers.

PART 2 PRODUCTS

2.1 COORDINATED POWER SYSTEM PROTECTION

Prepare analyses to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and

protection. 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 is not 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 must be performed by a registered professional engineer with demonstrated experience in power system coordination in the last 3 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.

2.1.1.1 Scope of Analyses

The fault current analysis and protective device coordination study must begin at: the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.

2.1.1.2 Determination of Facts

Determine and document the time-current characteristics, features, and nameplate data for each existing protective device. Coordinate with the [installation](#) for fault current availability at the site.

2.1.1.3 Single Line Diagram

Prepare a single line diagram 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 must have a unique identifier. If a fault-impedance diagram is provided, show impedance data. Show location of switches, breakers, and circuit interrupting devices on the diagram together with available fault data, and the device interrupting rating.

2.1.1.4 Fault Current Analysis

2.1.1.4.1 Method

Perform the fault current analysis in accordance with methods described in [IEEE 242](#), and [IEEE 399](#).

2.1.1.4.2 Data

Utilize actual data in fault calculations. Bus characteristics and transformer impedance must be those proposed. Document data in the report.

2.1.1.4.3 Fault Current Availability

Provide balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values at each voltage transformation point and at each power distribution bus. Show the maximum and minimum values of fault available at each location in tabular form on the diagram or in the report.

2.1.5 Coordination Study

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. Include a description of the coordination of the protective devices in this project. Provide a written narrative 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. Provide recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction). Provide composite coordination plots on log-log graph paper.

2.1.6 Study report

- a. Include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.
- b. Include descriptive and technical data for existing devices and new protective devices proposed. Include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.
- c. Document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings; .
- d. The report must 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. Include recommended ratings and settings of all protective devices in tabulated form.
- e. Provide the calculation performed for the analyses, including computer analysis programs utilized. Provide the name of the software package, developer, and version number.

PART 3 EXECUTION

Not Used

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

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 (2023) National Electrical Code

NFPA 780 (2023) Standard for the Installation of Lightning Protection Systems

UNDERWRITERS LABORATORIES (UL)

UL 96 (2016) UL Standard for Safety Lightning Protection Components

UL 467 (2022) UL Standard for Safety Grounding and Bonding Equipment

UL Electrical Construction (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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overall lightning protection system; G

Each major component; G

SD-06 Test Reports

Lightning Protection and Grounding System Test Plan; G

Lightning Protection and Grounding System Test; G

SD-07 Certificates

Lightning Protection System Installers Documentation; G

Component UL Listed and Labeled; G

Lightning protection system inspection certificate; G

Roof manufacturer's warranty; G

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.

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 Construction**, 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 Grounding Plates

Provide grounding plates made of copper-clad steel conforming to [UL 96](#).

2.2.4 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.

2.2.5 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, and 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. Roof conductors are to be concealed within the ceiling cavities as much as practicable.

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. Down conductors are to be concealed within the wall cavities.

3.1.3 Ground Connections

Attach each down conductor and ground ring electrode to ground rods by welding (including exothermic), brazing, or compression. 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 when a ground ring electrode is not used. 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. 1/0 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.

3.1.5 Grounding Plates

Provide a grounding plate for each down conductor. Set grounding plates not less than **3 feet** nor more than **8 feet**, from the structure foundation, and at least beyond the drip line for the facility. Grounding plate is to be buried as deeply in the existing dirt as local conditions allow,

without exceeding 10 feet in depth.

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.

3.3 INTERFACE WITH OTHER STRUCTURES

3.3.1 Fences

Bond metal fence and gate systems to the lightning protection system whenever the fence or gate is within 6 feet of any part of the lightning protection system in accordance with ANSI C2.

3.4 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.

3.5 FIELD QUALITY CONTROL

3.5.1 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 --

SECTION 26 51 00

INTERIOR LIGHTING
05/20, CHG 2: 11/21

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.

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2018) Standard Specification for Stainless Steel Wire
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 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 B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B633	(2019) 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

EUROPEAN UNION (EU)

Directive 2011/65/EU	(2011) Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
----------------------	--

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES LM-79	(2019) Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
ANSI/IES LM-80	(2020) Approved Method: Measuring Luminous Flux and Color Maintenance of LED

Packages, Arrays and Modules

ANSI/IES LS-1	(2020) Lighting Science: Nomenclature and Definitions for Illuminating Engineering
ANSI/IES TM-15	(2020) Technical Memorandum: Luminaire Classification System for Outdoor Luminaires
ANSI/IES TM-21	(2021) Technical Memorandum: Projecting Long-Term Luminous, Photon, and Radiant Flux Maintenance of LED Light Sources
ANSI/IES TM-30	(2020) Technical Memorandum: IES Method for Evaluating Light Source Color Rendition
IES Lighting Library	IES Lighting Library

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) 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 77	(2017) Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2017) Electric Lamps- Specifications for the Chromaticity of Solid State Lighting Products
NEMA C82.77-10	(2020) Harmonic Emission Limits - Related Power Quality Requirements
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA SSL 1	(2016) 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 2020) Standard for General Color Requirements for Wiring Devices

NEMA WD 7 (2011; R 2016; R 2021) Occupancy Motion
Sensors Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

NFPA 101 (2021; TIA 21-1) Life Safety Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 20 (2018; Reprint Jan 2021) UL Standard for
Safety General-Use Snap Switches

UL 94 (2013; Reprint Apr 2022) UL Standard for
Safety Tests for Flammability of Plastic
Materials for Parts in Devices and
Appliances

UL 508 (2018; Reprint Jul 2021) UL Standard for
Safety Industrial Control Equipment

UL 916 (2015; Reprint Oct 2021) UL Standard for
Safety Energy Management Equipment

UL 917 (2006; Reprint Aug 2013) UL Standard for
Safety Clock-Operated Switches

UL 924 (2016; Reprint May 2020) UL Standard for
Safety Emergency Lighting and Power
Equipment

UL 1472 (2015) UL Standard for Safety Solid-State
Dimming Controls

UL 1598 (2021; Reprint Jun 2021) Luminaires

UL 1598C (2014) Standard for Light-Emitting Diode
(LED) Retrofit Luminaire Conversion Kits

UL 2043 (2013) Fire Test for Heat and Visible
Smoke Release for Discrete Products and
Their Accessories Installed in
Air-Handling Spaces

UL 8750 (2015; Reprint Sep 2021) UL Standard for
Safety Light Emitting Diode (LED)
Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires, luminaire accessories, or
lighting equipment are specified in Section 26 20 00 INTERIOR DISTRIBUTION
SYSTEM. Luminaires and accessories that are mounted in exterior

environments and not attached to the exterior of the building are specified in Section 26 56 00 EXTERIOR LIGHTING.

1.3 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 ANSI/IES LS-1.
- 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 ANSI/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.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings; G

Lighting Control System One-Line Diagram; G

SD-03 Product Data

Luminaires; G

Light Sources; G

LED Drivers; G

Luminaire Warranty; G

Lighting Controls Warranty; G

Switches; G

Wall Box Dimmers; G

Occupancy/Vacancy Sensors; G

Time Clocks; G

Power Packs; G

Exit Signs; G

Emergency Drivers; G

SD-05 Design Data

Luminaire Design Data; G

SD-06 Test Reports

ANSI/IES LM-79 Test Report; G

ANSI/IES LM-80 Test Report; G

ANSI/IES TM-21 Test Report; G

ANSI/IES TM-30 Test Report; G

Occupancy/Vacancy Sensor Verification Test; G

Photosensor Verification Test; G

SD-07 Certificates

LED Driver and Dimming Switch Compatibility Certificate; G

SD-10 Operation and Maintenance Data

Lighting System, Data Package 5; G

Lighting Control System, Data Package 5; G

End-User Training Plan; G

1.5 QUALITY ASSURANCE

Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the IES Lighting Library as applicable, for the lighting system specified.

1.5.1 Luminaire Drawings

Include dimensions, accessories installation details, and construction details. Photometric data, including CRI, CCT, LED driver type, zonal lumen data, and candlepower distribution data must accompany shop drawings.

1.5.2 Luminaire Design Data

- a. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified in accordance with the NFPA 70. 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 ANSI/IES TM-21. Data used for projections must be

obtained from testing in accordance with [ANSI/IES LM-80](#).

1.5.3 [ANSI/IES LM-79 Test Report](#)

Submit test report on manufacturer's standard production model of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data in IES format as outlined under "14.0 Test Report" in [ANSI/IES LM-79](#).

1.5.4 [ANSI/IES LM-80 Test Report](#)

Submit report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "8.0 Test Report" in [ANSI/IES LM-80](#).

1.5.5 [ANSI/IES TM-21 Test Report](#)

Submit test report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in [ANSI/IES TM-21](#).

1.5.6 [ANSI/IES TM-30 Test Report](#)

Submit color vector graphic in accordance with [ANSI/IES TM-30](#) on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Include spectral distribution of test LED light source.

1.5.7 [LED Driver and Dimming Switch Compatibility Certificate](#)

Submit certification from the luminaire, driver, or dimmer switch manufacturer that ensures compatibility and operability between devices without flickering and to specified dimming levels.

1.5.8 Test Laboratories

Test laboratories for the [ANSI/IES LM-79](#) and [ANSI/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 for LM-79 testing.
- c. One of the EPA-Recognized Laboratories listed for LM-80 testing.

1.5.9 Regulatory Requirements

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. Provide luminaires and assembled components that are approved by and bear the label of UL for the

applicable location and conditions unless otherwise specified.

1.5.10 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 six months prior to bid opening. The six-month 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 six-month 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.

1.5.10.1 Alternative Qualifications

Products having less than a six-month 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.

1.5.10.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than six months prior to date of delivery to site, unless specified otherwise.

1.6 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.

1.6.1 Luminaire Warranty

Provide and transfer to the government the original LED luminaire manufacturers standard commercial warranty for each different luminaire manufacturer used in the project.

- a. Provide a written five year minimum replacement warranty for material, luminaire finish, and workmanship. Provide written warranty document that contains all warranty processing information needed, including customer service point of contact, whether or not a return authorization number is required, return shipping information, and closest return location to the luminaire location.

- (1) Finish warranty must include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

- (2) Material warranty must include:

- (a) All LED drivers and integral control equipment.

- (b) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) are defective, non-starting, or operating below 70 percent of specified lumen output.

- b. Warranty period must begin in accordance with the manufacturer's standard warranty starting date.
- c. Provide replacements that are promptly shipped, without charge, to the using Government facility point of contact and that are identical to or an improvement upon the original equipment. All replacements must include testing of new components and assembly.

1.6.2 Lighting Controls Warranty

Provide and transfer to the government the original lighting controls manufacturers standard commercial warranty for each different lighting controls manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Warranty service must be performed by a factory-trained engineer or technician.

- a. Unless otherwise noted, provide a written five year minimum warranty on the complete system for all systems with factory commissioning. Provide warranty that covers 100 percent of the cost of any replacement parts and services required over the five years which are directly attributable to the product failure. Failures include, but are not limited to, the following:
 - (1) Software: Failure of input/output to execute switching or dimming commands.
 - (2) Damage of electronic components due to transient voltage surges.
 - (3) Failure of control devices, including but not limited to occupancy sensors, photosensors, and manual wall station control devices.
- b. Provide a written five year minimum warranty on all input devices against defect in workmanship or materials provided by device manufacturer.
- c. Provide a written five year minimum warranty on all control components attached to luminaires against defect in workmanship or materials.

1.7 OPERATION AND MAINTENANCE MANUALS

1.7.1 Lighting System

Provide operation and maintenance manuals for the lighting system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting system for the building. Include the following:

- a. Manufacturers' operating and maintenance manuals.
- b. Luminaire shop drawings for modified and custom luminaires.
- c. Luminaire Manufacturers' standard commercial warranty information as specified in paragraph LUMINAIRE WARRANTY.

1.7.2 Lighting Control System

Provide operation and maintenance manuals for the lighting control system

in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting control system for the building. Include the following:

- a. Lighting control system layout and wiring plan.
- b. Lighting control system one-line diagram.
- c. Product data for all devices, including installation and programming instructions.
- d. Occupancy/vacancy sensor coverage layout.
- e. Training materials, such as videos or in-depth manuals, that cover basic operation of the lighting control system and instructions on modifying the lighting control system. Training materials must include calibration, adjustment, troubleshooting, maintenance, repair, and replacement.
- f. Sequence of operation descriptions for each typical room type, including final programming, schedules, and calibration settings.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES

UL 1598, NEMA C82.77-10. Provide luminaires as indicated in the luminaire schedule and NL plates or details on project plans, complete with light source, wattage, and lumen output indicated. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be specifically designed for use with the driver and light source provided.

2.2.1 Luminaires

UL 8750, ANSI/IES LM-79, ANSI/IES LM-80. For all luminaires, provide:

- a. Complete system with LED drivers and light sources.
- b. Housings constructed of non-corrosive materials. All new aluminum housings must be anodized or powder-coated. All new steel housings must be treated to be corrosion resistant.
- c. ANSI/IES TM-21, ANSI/IES LM-80. Minimum L70 lumen maintenance value of 50,000 hours unless otherwise indicated in the luminaire schedule. Luminaire drive current value must be identical to that provided by test data for luminaire in question.
- d. Minimum efficacy as specified in the luminaire schedule. Theoretical models of initial lamp lumens per watt are not acceptable. If efficacy values are not listed in the luminaire schedule, provide luminaires that meet the following minimum values:

Luminaire Style	Minimum Luminaire Efficacy
Recessed 1 by 4, 2 by 4, and 2 by 2	100 LPW
Recessed Downlight (fixed, adjustable, wallwash)	80 LPW
Linear, Accent (undercabinet, cove)	45 LPW
Linear, Ambient (indirect wall mount, linear pendent)	100 LPW
High Bay, Low Bay, and Industrial Locations	100 LPW
Food Service and Hazardous Locations	60 LPW
Other (track, residential diffusers)	50 LPW
Exterior Wall Sconce	50 LPW
Steplight	30 LPW
Parking Garage Luminaire	100 LPW

- e. UL listed for dry or damp location typical of interior installations. Any luminaire mounted on the exterior of the building must be UL listed for wet location typical of exterior installations.
- f. LED driver and light source package, array, or module are accessible for service or replacement without removal or destruction of luminaire.
- g. Lenses constructed of heat tempered borosilicate glass, UV-resistant acrylic, or silicone. Provide polycarbonate vandal-resistant lenses as indicated. Sandblasting, etching and polishing must be performed as indicated in the luminaire description.
- h. **ANSI/IES TM-15**. Provide exterior building-mounted luminaires that do not exceed the BUG ratings as listed in the luminaire schedule. If BUG ratings are not listed in the luminaire schedule, provide luminaires that meet the following minimum values for each application and mounting conditions:

Lighting Application	Mounting Conditions	BUG Rating
Exterior Wall Sconce	Above 4 feet AFF	B1-U0-G2
Exterior Wall Sconce	Below or at 4 feet AFF	B4-U0-G4
Steplight	Above 4 feet AFF	B1-U1-G2
Steplight	Below or at 4 feet AFF	B4-U1-G4
Parking Garage Luminaire	Ceiling mounted	B4-U4-G3

2.2.1.1 Luminaire Conversion Kits

Provide luminaire conversion kits that meet **UL 1598C** Standard for Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits.

2.3 LIGHT SOURCES

NEMA ANSLG C78.377, **NEMA SSL 3**. Provide type, delivered lumen output, and wattage as indicated in the luminaire schedule on project plans.

2.3.1 LED Light Sources

Provide LED light sources that meet the following requirements:

- a. **NEMA ANSLG C78.377**. Emit white light and have a nominal CCT of 3500 Kelvin.
- b. Minimum Color Rendering Index (CRI) of 90.
- c. **Directive 2011/65/EU**. Restriction of Hazardous Substances (RoHS) compliant.
- d. Light source color consistency by utilizing a binning tolerance within a 3-step McAdam ellipse.

2.4 LED DRIVERS

NEMA SSL 1, **UL 8750**. Provide LED drivers that are electronic, UL Class 1 or Class 2, constant-current type and that comply with the following requirements:

- a. The combined driver and LED light source system does not exceed the minimum luminaire efficacy values as listed in the luminaire schedule provided.
- b. Operates at a voltage of 120-277 volts at 50/60 hertz, with input voltage fluctuations of plus/minus 10 percent.
- c. Power Factor (PF) greater than or equal to 0.90 at full input power and across specified dimming range.
- d. Maximum Total Harmonic Distortion (THD) less than 20 percent at full input power and across specified dimming range.
- e. Operates for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.
- f. Withstands Category A surges of 2 kV without impairment of performance. Provide surge protection that is integral to the driver.
- g. Integral thermal protection that reduces the output power to protect the driver and light source from damage if the case temperature approaches or exceeds the driver's maximum operating temperature.
- h. **47 CFR 15**. Complies with the requirements of the Federal Communications Commission (FCC) rules and regulations, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
- i. Class A sound rating.

- j. **Directive 2011/65/EU**. Restriction of Hazardous Substances (RoHS) compliant.
- k. Provide dimming capability as indicated in the luminaire schedule on project plans. Dimmable drivers must dim down to 10 percent. Dimmable drivers must be controlled by a Class 2 low voltage 0-10VDC controller dimming signal protocol unless otherwise specified. LED drivers of the same family/series must track evenly across multiple luminaires at all light levels.

2.4.1 Remote LED Drivers

Provide remote LED Drivers that are UL listed for dry locations typical of interior installations. Provide LED driver in junction box or housing with mounting plate. Housing must allow for field connections to occur inside the housing or must contain mechanical connections.

2.5 LIGHTING CONTROLS

Provide lighting control systems that do not switch off battery-operated or emergency backup luminaires or exit signs in path of egress. Provide system with override of lighting control devices controlling luminaires in path of egress with activation of fire alarm system.

2.5.1 Devices

2.5.1.1 Switches

Provide line-voltage toggle switches as specified in Section **26 20 00 INTERIOR DISTRIBUTION SYSTEM**. When used for non-digital loads, devices must be rated at 20 Amps inductive load, and be compatible with the lighting control systems.

2.5.1.2 Wall Box Dimmers

UL 1472, UL 20, IEEE C62.41, NEMA 77, NEMA SSL 7A. Dimmers must provide flicker-free, continuously variable light output throughout the dimming range of 10 percent to 100 percent. 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.

Provide wall-box dimmers that meet the following requirements:

- a. Device operates as an independent control device.
- b. Device operates with the use of a vertical slider, paddle, rotary, button, or toggle with adjacent vertical slider.
- c. Finish of device matches switches and outlets in the same area.
- d. Back box in wall has sufficient depth to accommodate body of switch and wiring.
- e. Dimmer is capable of controlling 0-10 volt LED drivers. Dimmers and the drivers they control must be provided from the same manufacturer or tested and certified as compatible for use together.
- f. Radio frequency interference suppression is integral to device.

2.5.1.3 Occupancy/Vacancy Sensors

IEEE C62.41, NEMA WD 1, UL 94, UL 916, UL 508, ASTM D4674 REV A, NEMA WD 7. Provide occupancy/vacancy sensors with coverage patterns 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 of sensor provided. Provide occupancy sensor operation that requires movement to activate luminaires controlled and turns luminaires off after a set time of inactivity. Provide ceiling or wall-mounted occupancy/vacancy sensors that meet the following requirements:

- a. Operating voltage of 12-24120-277 volts.
- b. Time delay of 30 seconds to 30 minutes with at least four intermediate time delay settings.
- c. Sensors are ceiling mounted wall-box mounted.
- d. No minimum load requirement 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.
- e. Shielded or controlled by internal logic to adjust sensitivity to avoid false triggering due to ambient temperature, air temperature variations or HVAC air movement.
- f. Sensor is equipped to automatically energize the connected load upon loss of normal power when located in a means of egress.
- g. Occupancy and vacancy operation is field-adjustable and programmable with push-button or dip switch on the sensor device.
- h. No leakage current to load when in the off mode.
- i. Utilize zero-crossing circuitry to prevent damage from high inrush current and to promote long life operation.

2.5.1.3.1 Dual Technology Sensors

Provide dual technology sensors that meet the requirements for PIR sensors and ultrasonic sensors indicated above. If either the PIR or ultrasonic sensing registers occupancy, the luminaires must remain on.

2.5.1.3.2 Power Packs

UL 2043. Provide power packs to provide power to lighting control sensors as required in accordance with the manufacturer's specifications. Provide power packs that meet the following requirements:

- a. Operate at an input voltage of 120-277 VAC, with an output voltage 12-24 VDC at 225 mA.
- b. Constructed of 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 LED lighting loads.

- e. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

2.5.1.4 Time Clocks

UL 917, NEMA ICS 6. House time clock in a surface-mounted, lockable, NEMA 1 enclosure constructed of painted steel or plastic polymer. Provide electronic type time clock that meets the following criteria:

- a. Astronomic programming function, providing a total of 96 on/off set points.
- b. 24 hour type digital clock display format.
- c. Power outage back-up for time clock utilizing lithium battery which provides coverage for a minimum of seven days.
- d. Capable of controlling a minimum of 4 channels or loads.
- e. Contacts are rated for 30 amps at 120-277 VAC resistive load in a SPST normally open (NO) configuration.
- f. Contains 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 EEPROM memory module momentary function for output contacts ability for photosensor input.

2.6 EXIT AND EMERGENCY LIGHTING EQUIPMENT

2.6.1 Exit Signs

UL 924, NFPA 101. Provide wattage as indicated in the luminaire schedule on project plans. Provide LED Exit Signs that meet the following criteria:

- a. Housing constructed of UV-stable, thermo-plastic.
- b. UL listed for damp location.
- c. Configured for universal mounting.
- d. 6 inch high, 3/4 inch stroke red lettering on face of sign with chevrons on either side of lettering to indicate direction.
- e. Single or double face as indicated in project plans and luminaire schedule.

2.6.1.1 Exit Signs with Battery Backup

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. In lieu of battery, can use a nonradioactive photoluminescent plate.

2.6.1.2 Remote-Powered Exit Signs

Provide exit sign that contains provision for 120-277 VAC input from remote source.

2.6.2 Emergency Lighting Unit (ELU)

UL 924, NFPA 101. Provide emergency lighting units (ELUs) completely assembled with wiring and mounting devices, ready for installation at the locations indicated. Provide in UV-stable, thermo-plastic housing with UL damp label as indicated. Emergency lighting units must be rated for 12 volts, except units having no remote-mounted light sources 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 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 90 minutes. 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

UL 924, NFPA 101. 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 nickel-cadmium battery is required to supply a minimum of 90 minutes of emergency power at 7 watts, 10-50 VDC, constant output. 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 Drivers

UL 924, NFPA 101. Provide emergency lighting unit with fully-automatic, integral self-testing/diagnostic electronic circuitry. Circuitry must provide for a one minute 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 MOUNTING ACCESSORIES

2.7.1 Suspended Luminaires

- a. Provide hangers capable of supporting twice the combined weight of luminaires supported by hangers.
- b. Hangers must allow luminaires to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging.
- c. Single-unit suspended luminaires must have cable/twin-stem hangers. Multiple-unit or continuous row luminaires with a separate power supply cord 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.

- d. Provide all linear pendent and surface mounted luminaires with two supports per four-foot section or three per eight-foot section unless otherwise recommended by manufacturer.
- e. Provide rods in minimum 0.18 inch diameter.

2.7.2 Recess and Surface Mounted Luminaires

Provide access to light source and LED driver from bottom of luminaire. Provide trim and lenses for the exposed surface of flush-mounted luminaires as indicated on project drawings and specifications. Luminaires recessed in ceilings which have a fire resistive rating of one hour or more must be enclosed in a box which has a fire resistive rating equal to that of the ceiling. For surface mounted luminaires with brackets, provide flanged metal stem attached to outlet box, with threaded end suitable for supporting the luminaire rigidly in design position. Flanged part of luminaire stud must be of broad base type, secured to outlet box at not fewer than three points.

2.7.3 Luminaire Support Hardware

2.7.3.1 Wire

ASTM A641/A641M. Galvanized, soft tempered steel, minimum 0.11 inches in diameter, or galvanized, braided steel, minimum 0.08 inches in diameter.

2.7.3.2 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.

2.7.3.3 Threaded Rods

Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.7.3.4 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 EQUIPMENT IDENTIFICATION

2.8.1 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.

2.8.2 Labels

UL 1598. All luminaires must be clearly marked for operation of specific light sources and LED drivers. The labels must be easy to read when

standing next to the equipment, and durable to match the life of the equipment to which they are attached. Note the following light source characteristics in the format "Use Only _____":

- a. Correlated Color Temperature (CCT) and Color Rendering Index (CRI) for all luminaires.
- b. Driver and dimming protocol.

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. LED drivers must have clear markings indicating dimming type and indicate proper terminals for the various outputs.

2.9 FACTORY APPLIED FINISH

NEMA 250. Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum, meets requirements of corrosion-resistance testing.

PART 3 EXECUTION

3.1 INSTALLATION

IEEE C2, NFPA 70.

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 (CCT), color rendering index (CRI), 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. Provide accessories as required for ceiling construction type indicated on Finish Schedule. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed. Provide wires, straps, or rods for luminaire support in this section. Install luminaires with vent holes free of air blocking obstacles.

3.1.2.1 Suspended Luminaires

Measure mounting heights from the bottom of the luminaire for ceiling-mounted luminaires and to center of luminaire for wall-mounted luminaires. Obtain architect 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. Support suspended luminaires from structural framework of ceiling or from inserts cast into slab.

- a. Provide suspended luminaires with 45 degree swivel hangers so that they hang plumb and level.

- b. Locate so that there are no obstructions within the 45 degree range in all directions.
- c. The stem, canopy and luminaire must be capable of 45 degree swing.
- d. Rigid pendent stem, aircraft cable, rods, or chains 4 feet or longer excluding luminaire must be braced to prevent swaying using three cables at 120 degree separation.
- e. 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.
- f. Utilize aligning splines on extruded aluminum luminaires to assure minimal hairline joints.
- g. Support steel luminaires to prevent "oil-canning" effects.
- h. Match supporting pendants with supported luminaire. Aircraft cable must be stainless steel.
- i. Match finish of canopies to match the ceiling, and provide low profile canopies unless otherwise shown.
- j. Maximum distance between suspension points must be 10 feet or as recommended by the manufacturer, whichever is less.

3.1.2.2 Recessed and Semi-Recessed Luminaires

- a. Support recessed and semi-recessed luminaires independently from the building structure by a minimum of two wires, straps or rods per luminaire and located near opposite corners of the luminaire. Secure horizontal movement with clips provided by manufacturer. Ceiling grid clips are not allowed as an alternative to independently supported luminaires.
- b. Support round luminaires or luminaires smaller in size than the ceiling grid independently from the building structure by a minimum of four wires, straps or rods per luminaire, spaced approximately equidistant around.
- c. Do not support luminaires by acoustical tile ceiling panels.
- d. 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.
- e. Luminaires installed in suspended ceilings must also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.
- f. Adjust aperture rings on all applicable ceiling recessed luminaires to accommodate various ceiling material thickness. Coordinate cut-out size in ceiling to ensure aperture covers cut-out entirely. Install aperture rings such that the bottom of the ring is flush with finished ceiling or not more than 1/16 inch above. Do not install luminaires such that the aperture ring extends below the finished ceiling surface.

- g. For luminaire recessed in plaster ceilings, provide plaster frames for setting. Install setting such that the bottom of the frame is flush with finished ceiling. Support luminaires with plaster frames utilizing yokes or leveling lugs. Do not mount luminaires or support elements to ducts or pipes. Yokes must support a luminaire by no fewer than two bolts each.

3.1.3 LED Drivers

Provide LED drivers integral to luminaire as constructed by the manufacturer.

3.1.3.1 Remote LED Drivers

Locate Remote LED Drivers within the maximum distance allowed to minimize voltage drop. Do not locate remote LED drivers further from the light source than specified by the manufacturer. Locate remote LED drivers in dry, well-ventilated, and accessible location, above accessible ceilings or behind a removable wall or ceiling panel. Mount housing or junction box so that it is rigidly and securely fastened in place. Install LED drivers such that components are not in contact with combustible materials unless listed for such condition. Remote LED drivers must be grounded in accordance with [NFPA 70](#).

Provide separate compartments for Class 2 wiring connections and for Class 1 wiring connections. Separation must be barrier-type within the same box or separate boxes with close connector conduit fittings. Field connections must be inside housing or junction box or secured by a quick disconnect wire connector.

3.1.4 Exit Signs

[NFPA 101](#). Wire exit signs and emergency lighting units ahead of the local switch, to the normal lighting circuit located in the same room or area.

Connect exit signs on separate circuits and serve from a separate circuit breaker. Provide only one source of control, which would be the separate circuit breaker. Paint source of control red and provide lockout capability.

3.1.5 Lighting Controls

Refer [below](#) for additional lighting control installation requirements.

3.1.5.1 Occupancy/Vacancy Sensors

- a. 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.
- b. Locate ceiling-mounted sensors no closer than [6 feet](#) from the nearest HVAC supply or return diffuser.
- c. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

3.2.1.1 Lighting Control Verification Tests

Verify lighting control system and devices operate according to approved sequence of operations. Verification tests are to be completed after commissioning.

- a. Verify occupancy/vacancy sensors operate as described in sequence of operations. Provide testing of sensor coverage, sensitivity, and time-out settings in all spaces where sensors are placed. This is to be completed only after all furnishings have been installed. Submit [occupancy/vacancy sensor verification test](#).
- b. Verify photosensors operate as described in sequence of operations. Provide testing of sensor coverage, aiming, and calibration in all spaces where sensors are placed. This is to be completed only after all furnishings have been installed. Submit [photosensor verification test](#).
- c. Verify wall box dimmers and scene wallstations operate as described in sequence of operations.

3.2.1.2 Emergency Lighting Test

Interrupt power supply to demonstrate proper operation of emergency lighting. If adjustments are made to the lighting system, re-test system to show compliance with standards.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Training

3.3.1.1 End-User Training

Submit an [End-User Training Plan](#) at least 30 calendar days prior to training session that describes training procedures for end-users on the lighting control system. Provide users with a list of control devices located within user-occupied spaces, such as photosensors and occupancy and vacancy sensors, including information on the proper operation and schedule for each device. Provide demonstration for each type of interface. Provide users with the building schedule as currently commissioned, including conditional programming based on astronomic time clock functionality. Provide users with the correct contact information for maintenance personnel who will be available to address any lighting control issues.

Provide laminated instructions to the user at each scene wallstation. Provide only instructions relevant to the functionality of the specific scene wallstation. Provide a description of each labeled scene control button. If the room utilizes occupancy/vacancy sensors or photosensors, include a description of this functionality on the instruction sheet.

-- End of Section --

SECTION 26 56 00

EXTERIOR LIGHTING
08/21

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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO LTS (2013; Errata 2013) Standard
Specifications for Structural Supports for
Highway Signs, Luminaires and Traffic
Signals

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M (2016a) Standard Specification for Zinc
Coating (Hot-Dip) on Iron and Steel
Hardware

ASTM B108/B108M (2019) Standard Specification for
Aluminum-Alloy Permanent Mold Castings

ASTM B117 (2019) Standard Practice for Operating
Salt Spray (Fog) Apparatus

EUROPEAN UNION (EU)

Directive 2011/65/EU (2011) Restriction of the Use of Certain
Hazardous Substances in Electrical and
Electronic Equipment

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES LM-79 (2019) Approved Method: Electrical and
Photometric Measurements of Solid State
Lighting Products

ANSI/IES LM-80 (2020) Approved Method: Measuring Luminous
Flux and Color Maintenance of LED
Packages, Arrays and Modules

ANSI/IES LS-1 (2020) Lighting Science: Nomenclature and
Definitions for Illuminating Engineering

ANSI/IES RP-8 (2018; Addenda 1 2020; Errata 1-2 2021)
Recommended Practice for Design and
Maintenance of Roadway and Parking
Facility Lighting

ANSI/IES TM-15 (2020) Technical Memorandum: Luminaire

Classification System for Outdoor
Luminaires

ANSI/IES TM-21

(2021) Technical Memorandum: Projecting
Long-Term Luminous, Photon, and Radiant
Flux Maintenance of LED Light Sources

IES Lighting Library

IES Lighting Library

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100

(2000; Archived) The Authoritative
Dictionary of IEEE Standards Terms

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

(2020) Roadway and Area Lighting Equipment
- Luminaire Attachments

ANSI C136.13

(2020) Roadway and Area Lighting Equipment
- Metal Brackets for Wood Poles

ANSI C136.21

(2014) American National Standard for
Roadway and Area Lighting Equipment -
Vertical Tenons Used with Post-Top-Mounted
Luminaires

NEMA 250

(2020) Enclosures for Electrical Equipment
(1000 Volts Maximum)

NEMA ANSLG C78.377

(2017) Electric Lamps- Specifications for
the Chromaticity of Solid State Lighting
Products

NEMA C82.77-10

(2020) Harmonic Emission Limits - Related
Power Quality Requirements

NEMA C136.10

(2017) American National Standard for
Roadway and Area Lighting
Equipment-Locking-Type Photocontrol
Devices and Mating Receptacles--Physical
and Electrical Interchangeability and
Testing

NEMA C136.31

(2018) Roadway and Area Lighting Equipment
- Luminaire Vibration

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 SSL 1

(2016) Electronic Drivers for LED Devices,

Arrays, or Systems

NEMA SSL 3 (2011) High-Power White LED Binning for
General Illumination

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 773 (2016; Reprint Jul 2020) UL Standard for
Safety Plug-In, Locking Type Photocontrols
for Use with Area Lighting

UL 773A (2016; Reprint Jun 2020) UL Standard for
Safety Nonindustrial Photoelectric
Switches for Lighting Control

UL 1310 (2018; Reprint Jun 2022) UL Standard for
Safety Class 2 Power Units

UL 1598 (2021; Reprint Jun 2021) Luminaires

UL 8750 (2015; Reprint Sep 2021) UL Standard for
Safety Light Emitting Diode (LED)
Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires, luminaire accessories, or lighting equipment are specified in Section(s) 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION. Luminaires and accessories installed in interior of buildings or attached to the exterior of a building are specified in Section 26 51 00 INTERIOR LIGHTING.

1.3 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 ANSI/IES LS-1.
- 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 ANSI/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.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings; G

Pole Drawings; G

SD-03 Product Data

Luminaires; G

Light Sources; G

LED Drivers; G

Luminaire Warranty; G

Lighting Controls Warranty; G

Pole Warranty; G

Photosensors; G

Time Clock; G

Lighting Contactor; G

Poles; G

Brackets

SD-05 Design Data

Luminaire Design Data; G

SD-06 Test Reports

ANSI/IES LM-79 Test Report; G

ANSI/IES LM-80 Test Report; G

ANSI/IES TM-21 Test Report; G

SD-08 Manufacturer's Instructions

Poles

SD-10 Operation and Maintenance Data

Lighting System, Data Package 5; G

End-User Training Plan; G

1.5 QUALITY ASSURANCE

Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the [IES Lighting Library](#) as applicable, for the lighting system specified.

1.5.1 Drawing Requirements

1.5.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), weight, accessories, and installation and construction details. Photometric data, including CRI, CCT, TM-15-11 BUG rating, LED driver type, zonal lumen data, and candlepower distribution data per LM-79 must accompany shop drawings.

1.5.1.2 Pole Drawings

Include dimensions, wind load determined in accordance with [AASHTO LTS](#), pole deflection, pole class, and other applicable information.

1.5.2 Luminaire Design Data

- a. Provide distribution data according to IES classification type as defined in [IES Lighting Library](#) and [ANSI/IES RP-8](#).
- b. B.U.G. rating for the installed position as defined by [ANSI/IES TM-15](#) and shielding as defined by [ANSI/IES RP-8](#).
- c. Provide safety certification and file number for the luminaire family. Include listing, labeling and identification in accordance with [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 [ANSI/IES TM-21](#). Data used for projections must be obtained from testing in accordance with [ANSI/IES LM-80](#).
- e. Provide wind loading calculations for luminaires mounted on poles. Weight and effective projected area (EPA) of luminaires and mounting brackets must not exceed maximum rating of pole as installed in particular wind zone area.

1.5.3 [ANSI/IES LM-79](#) Test Report

Submit test report on manufacturer's standard production model of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "14.0 Test Report" in [ANSI/IES LM-79](#).

1.5.4 [ANSI/IES LM-80](#) Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be

performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "8.0 Test Report" in [ANSI/IES LM-80](#).

1.5.5 [ANSI/IES TM-21 Test Report](#)

Submit test report on manufacturer's standard production LED light source (package, array or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in [ANSI/IES TM-21](#).

1.5.6 Test Laboratories

Test laboratories for the [ANSI/IES LM-79](#) and [ANSI/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.
- b. One of the qualified labs listed on the Department of Energy - Energy Efficiency & Renewable Energy, Solid-State Lighting web site.
- c. One of the EPA-Recognized Laboratories listed at for LM-80 testing.

1.5.7 Regulatory Requirements

Equipment, materials, installation, and workmanship must be in accordance with the mandatory provisions of [NFPA 70](#) unless more stringent requirements are specified or indicated. Provide luminaires and assembled components that are approved by and bear the label of UL for the applicable location and conditions unless otherwise specified.

1.5.8 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 six months prior to bid opening. The six-month 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 six-month 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.

1.5.8.1 Alternative Qualifications

Products having less than a six-month 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.

1.5.8.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than six months prior to date of

delivery to site, unless specified otherwise.

1.6 DELIVERY, STORAGE, AND HANDLING OF POLES

1.6.1 Aluminum Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.7 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.

1.7.1 Luminaire Warranty

Provide and transfer to the government the original LED luminaire manufacturers standard commercial warranty for each different luminaire manufacturer used in the project.

- a. Provide a written five year minimum replacement warranty for material, luminaire finish, and workmanship. Provide written warranty document that contains all warranty processing information needed, including customer service point of contact, whether or not a return authorization number is required, return shipping information, and closest return location to the luminaire location.

- (1) Finish warranty must include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

- (2) Material warranty must include:

- (a) All LED drivers and integral control equipment.

- (b) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) are defective, non-starting, or operating below 70 percent of specified lumen output.

- b. Warranty period must begin in accordance with the manufacturer's standard warranty starting date.

- c. Provide replacements that are promptly shipped, without charge, to the using Government facility point of contact and that are identical to or an improvement upon the original equipment. All replacements must include testing of new components and installation.

1.7.2 Lighting Controls Warranty

Provide and transfer to the government the original lighting controls manufacturers standard commercial warranty for each different lighting controls manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Warranty service must be performed by a factory-trained engineer or technician.

- a. Unless otherwise noted, provide a written five year minimum warranty

on the complete system for all systems with factory commissioning. Provide warranty that covers 100 percent of the cost of any replacement parts and services required over the five years which are directly attributable to the product failure. Failures include, but are not limited to, the following:

- (1) Software: Failure of input/output to execute switching or dimming commands.
 - (2) Damage of electronic components due to transient voltage surges.
 - (3) Failure of control devices, including but not limited to photosensors and motion sensors.
- b. Provide a written five year minimum warranty on all input devices against defect in workmanship or materials provided by device manufacturer.
- c. Provide a written five year minimum warranty on all control components attached to luminaires against defect in workmanship or materials.

1.7.3 Pole Warranty

Provide and transfer to the government the original pole manufacturers standard commercial warranty for each different pole manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Provide a written three year minimum replacement warranty for material, luminaire finish, and workmanship. Warranty service must be performed by a factory-trained engineer or technician.

1.8 OPERATION AND MAINTENANCE MANUALS

1.8.1 Lighting System

Provide operation and maintenance manuals for the lighting system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting system. Include the following:

- a. Manufacturers' operating and maintenance manuals.
- b. Luminaire shop drawings for modified and custom luminaires.
- c. Luminaire Manufacturers' standard commercial warranty information as specified in paragraph LUMINAIRE WARRANTY.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES

UL 1598, NEMA C82.77-10. Provide luminaires as indicated in the luminaire schedule and XL plates or details on project plans, complete with light source, wattage, and lumen output indicated. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be specifically designed for use with the LED driver and light source provided.

2.2.1 Luminaires

UL 8750, ANSI/IES LM-79, ANSI/IES LM-80. For all luminaires, provide:

- a. Complete system with LED drivers and light sources.
- b. Housing constructed of non-corrosive materials. All new aluminum housings must be anodized or powder-coated. All new steel housings must be treated to be corrosion resistant.
- c. ANSI/IES TM-21, ANSI/IES LM-80. Minimum L70 lumen maintenance value of 50,000 hours unless otherwise indicated in the luminaire schedule. Luminaire drive current value must be identical to that provided by test data for luminaire in question.
- d. Minimum efficacy as specified in the luminaire schedule. Theoretical models of initial lamp lumens per watt are not acceptable. If efficacy values are not listed in the luminaire schedule, provide luminaires that meet the following minimum values:

Luminaire Style	Minimum Luminaire Efficacy
Area and Roadway (pole mounted, arm mounted)	119 LPW
Pedestrian Post-Top (pole mounted, arm mounted)	97 LPW
Bollard	45 LPW
Accent (adjustable landscape, sign lighting)	35 LPW
Linear Accent (facade, wallwash)	80 LPW
Exterior Wall Sconce	50 LPW
Steplight	30 LPW
Parking Garage Luminaire	113 LPW

- e. Product rated for operation within an ambient temperature range of minus 22 degrees F to 122 degrees F.
- f. UL listed for wet locations.
- g. IES Lighting Library. Light distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans.
- h. Housing finish that is baked-on enamel, anodized, or baked-on powder coat paint. Finish must be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.
- i. LED driver and light source package, array, or module are accessible for service or replacement without removal or destruction of luminaire.
- j. ANSI/IES TM-15. Does not exceed the BUG ratings as listed in the luminaire schedule.. If BUG ratings are not listed in the luminaire

schedule, provide luminaires that meet the following minimum values for each application and mounting conditions:

Lighting Application	Mounting Conditions	BUG Rating
Area and Roadway	All	B3-U0-G3
Pedestrian Post-Top	All	B2-U1-G1
Exterior Wall Sconce	Above 4 feet AFF	B1-U0-G2
Exterior Wall Sconce	Below or at 4 feet AFF	B4-U0-G4
Steplight	Above 4 feet AFF	B1-U1-G2
Steplight	Below or at 4 feet AFF	B4-U1-G4
Parking Garage Luminaire	Ceiling mounted	B4-U4-G3

- k. Fully assembled and electrically tested prior to shipment from factory.
- l. Finish color is as indicated in the luminaire schedule or detail on the project plans.
- m. Lenses constructed of clearfrosted tempered glass or UV-resistant acrylic. Provide polycarbonate vandal-resistant lenses.
- n. All factory electrical connections are made using crimp, locking, or latching style connectors. Twist-style wire nuts are not acceptable.
- o. NEMA C136.31. Comply with 3G vibration testing.
- p. Luminaire arm bolts constructed from 304 stainless steel or zinc-plated steel.
- q. Wiring compartment on pole-mounted, street and area luminaires is accessible without the use of hand tools to manipulate small screws, bolts, or hardware.
- r. Incorporate modular electrical connections, and construct luminaires to allow replacement of all or any part of the optics, heat sinks, LED drivers, surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.
- s. ANSI C136.3. For all roadway and area luminaires, provide products with an integral tilt adjustment of plus or minus 5 degrees to allow the unit to be leveled.

2.3 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type, lumen rating, and wattage as indicated in luminaire schedule on project plans.

2.3.1 LED Light Sources

Provide LED light sources that meet the following requirements:

- a. **NEMA ANSLG C78.377**. Emit white light and have a nominal Correlated Color Temperature (CCT) of 4000 Kelvin.
- b. Minimum Color Rendering Index (CRI) of 80.
- c. **Directive 2011/65/EU**. Restriction of Hazardous Substances (RoHS) compliant.
- d. Light source color consistency by utilizing a binning tolerance within a 4-step McAdam ellipse.

2.4 LED DRIVERS

NEMA SSL 1, UL 1310. Provide LED Drivers that are electronic, UL Class 1 or Class 2, constant-current type and meet the following requirements:

- a. The combined LED driver and LED light source system is greater than or equal to the minimum luminaire efficacy values as listed in the luminaire schedule provided.
- b. Operate at a voltage of 120-277 volts at 50/60 hertz, with input voltage fluctuations of plus or minus 10 percent.
- c. Power Factor (PF) greater than or equal to 0.90 at full input power and across specified dimming range.
- d. Maximum Total Harmonic Distortion (THD) less than or equal to 20 percent at full input power and across specified dimming range.
- e. Operates for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.
- f. Meets the "Elevated" (10kV/10kA) requirements per **IEEE C62.41.2-2002**. Manufacturer must indicate whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire. Provide surge protection that is integral to the LED driver.
- g. Contains integral thermal protection that reduces the output power to protect the driver and light source from damage if the case temperature approaches or exceeds the driver's maximum operating temperature.
- h. Complies with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
- i. Class A sound rating for all drivers mounted under a covered structure, such as a canopy, or where otherwise appropriate.
- j. **Directive 2011/65/EU**. Restriction of Hazardous Substances (RoHS) compliant.
- k. UL listed for wet locations typical of exterior installations.
- l. Non-dimmable.
- m. Rated to operate between ambient temperatures of **minus 22 degrees F** and **104 degrees F 122 degrees F**.

2.4.1 Remote LED Drivers

Provide remote LED Drivers that are UL listed for wet locations typical of exterior installations.

2.5 LIGHTING CONTROLS

Provide a control system interface within each luminaire that is compatible with the energy management or control system used by the utility department in charge of the project area for control of site lighting.

2.5.1 Devices

2.5.1.1 Time Clock

NEMA ICS 6. House time clock in a surface-mounted, lockable NEMA 1 enclosure constructed of painted steel or plastic polymer. Provide electronic type time clock that meets the following criteria:

- a. astronomic programming function, providing a total of 56 on/off set points.
- b. 24 hour type digital clock display format.
- c. Power outage back-up for switch utilizing lithium battery which provides coverage for a minimum of seven days.
- d. Capable of controlling a minimum of 4 channels or loads.
- e. Contacts are rated for 30 amps at 120-277 VAC resistive load in a SPST normally open (NO) configuration.
- f. Contains 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 EEPROM memory module momentary function for output contacts ability for photosensor input.

2.5.1.2 Photosensors

UL 773, UL 773A. Provide Photosensors that meet the following requirements:

- a. Hermetically sealed, silicon diode light sensor type, rated at watts, volts, 50/60 Hz with single-pole, single-throw contacts.
- b. Turns ON at 1 to 3 footcandles and turns OFF at 3 to 15 footcandles.
- c. Designed to fail to the ON position.
- d. Housing is constructed of UV stabilized polypropylene, rated to operate within a temperature range of minus 40 to 158 degrees F.
- e. Time delay that prevents accidental switching from transient light sources.
- f. Directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.

- g. Designed for 20-year service to match life expectancy of long-life LED fixtures and exceed 15,000 operations at full load. Provide photosensors with zero-cross technology to withstand severe in-rush current and extend relay life.
- h. Swivel base type housing with 1/2 in threaded base for mounting to a junction box or conduit.
- i. **NEMA C136.10**. Twist-lock receptacle type. Provide with solid brass prongs and voltage markings and color coding on exterior of housing.
- j. Provide photosensors with metal oxide varistor (MOV) type surge protection.

2.5.1.3 Lighting Contactor

NEMA ICS 2. Provide a mechanically-held lighting contactor housed in a NEMA 1 enclosure conforming to NEMA ICS 6. Contactor must have 6 poles, configured as normally open (NO). Contacts must be rated 600 volts, 30 amperes for a resistive load. Coil operating voltage must be 120 volts. Contactor must have silver cadmium oxide double-break contacts and coil clearing contacts for mechanically held contactors and must require no arcing contacts. Provide contactor with hand-off-automatic on-off selector switch. Provide contactor as specified above along with circuit breaker in integral NEMA 1 enclosure with flange-mounted handle to satisfy requirement for a "combination lighting contactor" when specified.

2.6 POLES

AASHTO LTS. Provide straight poles designed for wind loading of 150 miles per hour while supporting luminaires and all other appurtenances indicated. The effective projected areas (EPA) of luminaires and appurtenances used in calculations must be specific for the actual products provided on each pole. Provide poles that are anchor-base type designed for use with underground supply conductors. Provide metal poles with an internal grounding connection accessible from the hand hole near the bottom of each pole. Install a means of wire disconnection accessible from the hand hole. Do not install square poles. Provide poles from a Manufacturer with a standard provision for protecting the finish during shipment and installation. Do not install scratched, stained, chipped, or dented poles.

2.6.1 Aluminum Poles

Provide aluminum poles with uniform satin finish unless otherwise noted in luminaire schedule on project plans. Do not paint aluminum poles. Provide poles that meet the following requirements:

- a. **AASHTO LTS**. Manufactured of corrosion resistant aluminum alloys for Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys and Alloy 356-T4 (3,5) for cast alloys.
- b. Seamless extruded or spun seamless-type with minimum 0.188 inch wall thickness.
- c. Top of shaft is fitted with a round or tapered cover.
- d. **ASTM B108/B108M**. Pole base is mounted by anchor bolts, made of cast

356-T6 aluminum alloy. Base must be machined to receive the lower end of shaft.

- e. Joint between shaft and base is welded.
- f. **ASTM B108/B108M**. Base cover is cast 356-T6 aluminum alloy.
- g. All hardware other than anchor bolts are either 2024-T4 anodized aluminum alloy or stainless steel.
- h. Grounding connection is designed to prevent electrolysis when used with copper ground wire.

2.6.2 **Brackets** and Supports

ANSI C136.3, **ANSI C136.13**, and **ANSI C136.21**. Provide pole brackets that are not less than 1 1/4 inch aluminum secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets must be coordinated to luminaires provided, and brackets for use with one type of luminaire must be identical. Brackets for pole-mounted street lights must correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 24 feet above street. Provide special mountings or brackets as indicated and of metal which will not promote galvanic reaction with luminaire head.

2.6.3 Pole Foundations

Provide anchor bolts consisting of a steel rod with a minimum yield strength of 50,000 psi; the top 12 inches of the rod must be galvanized in accordance with **ASTM A153/A153M**. Concrete must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7 EQUIPMENT IDENTIFICATION

2.7.1 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.

2.7.2 Labels

UL 1598. Luminaires must be clearly marked for operation of specific light sources and drivers according to proper light source type. Note the following luminaire characteristics in the format "Use Only _____":

- a. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.
- b. Driver and dimming protocol.

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. LED drivers must have clear markings indicating dimming type and indicate proper terminals for the various outputs.

2.8 FACTORY APPLIED FINISH

NEMA 250. Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum meets requirements of corrosion-resistance testing.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Luminaires

Install all luminaires in accordance with the luminaire manufacturer's written instructions. Install all luminaires at locations and heights as indicated on the project plans. Level all luminaires in accordance to manufacturer's written instructions.

3.1.2 LED Drivers

Provide LED drivers integral to luminaire as constructed by the manufacturer.

3.1.2.1 Remote LED Drivers

Locate Remote LED Drivers within the maximum distance allowed to reduce voltage drop. Do not locate remote LED drivers further from the light source than specified by the manufacturer. Locate remote LED drivers in dry, well-ventilated, and accessible location, or in accessible IP68-rated enclosure. Provide separate compartments for Class 2 wiring connections and for Class 1 wiring connections. Separation must be barrier-type within the same box or separate boxes with close connector conduit fittings. Field connections must be inside housing or junction box or secured by a quick disconnect wire connector suitable for wet-location. Remote LED drivers must be electronically grounded in accordance with **NFPA 70**.

3.1.3 Lighting Controls

Refer **below** for additional lighting control installation requirements.

3.1.3.1 Photosensors

Aim photosensor according to manufacturer's recommendations. Mount sensor on or beside each luminaire when switch is provided in cast weatherproof aluminum housing with swivel arm.

3.1.4 Grounding

Ground noncurrent-carrying parts of equipment including metal poles, 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.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

Upon completion of installation, verify that equipment is properly

installed, connected, and adjusted. Perform initial operational test, consisting of the entire system energized for 72 consecutive hours without any failures of any kind occurring in the system. All circuits must test clear of faults, grounds, and open circuits.

3.2.1.1 Lighting Control Verification Test

Verify lighting control system and devices operate according to approved sequence of operations. Verification tests are to be completed after commissioning.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Training

Provide on-site training to the Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide training that includes calibration, adjustment, troubleshooting, maintenance, repair, and replacement.

3.3.1.1 End-User Training

Submit a [End-User Training Plan](#) at least 30 calendar days prior to training session that describes training procedures for end-users on the lighting control system. Provide demonstration for each type of user interface. Provide users with the curfew schedule as currently commissioned, including conditional programming based on astronomic time clock functionality. Provide users with the correct contact information for maintenance personnel who will be available to address any lighting control issues.

-- End of Section --

SECTION 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM (MCBCL)
04/22

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)

ECIA EIA/ECA 310-E (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 (2021) Category 3 and 5E Individually
Unshielded Twisted Pairs, Indoor Cables
(With or Without an Overall Shield) for
Use in General Purpose and LAN
Communications Wiring Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA/BICSI 568 (2006) Standard for Installing Building
Telecommunications Cabling

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 66 (2019) Performance Standard for Category 6
and Category 7 100 Ohm Shielded and
Unshielded Twisted Pairs

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-526-7 (2015a) OFSTP-7 Measurement of Optical
Power Loss of Installed Single-Mode Fiber
Cable Plant

TIA-568.0	(2020e) Generic Telecommunications Cabling for Customer Premises
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2	(2018d) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	(2016d; Add 1 2019) Optical Fiber Cabling Components Standard
TIA-569	(2019e) Telecommunications Pathways and Spaces
TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
TIA-1152	(2016; R 2021) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
TIA/EIA-598	(2014D; Add 2 2018) Optical Fiber Cable Color Coding
TIA/EIA-604-3	(2004b; R 2014) Fiber Optic Connector Intermateability Standard (FOCIS), Type SC and SC-APC, FOCIS-3

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 68	Connection of Terminal Equipment to the Telephone Network (47 CFR 68)
-------------	---

UNDERWRITERS LABORATORIES (UL)

UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 444	(2017; Reprint Jun 2021) UL Standard for Safety Communications Cables
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 969	(2017; Reprint Mar 2018) UL Standard for Safety Marking and Labeling Systems

UL 1286	(2008; Reprint Apr 2021) UL Standard for Safety Office Furnishings
UL 1666	(2007; Reprint Sep 2021) UL Standard for Safety Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
UL 1863	(2004; Reprint Oct 2019) UL Standard for Safety Communication Circuit Accessories

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and Section 33 82 00 TELECOMMUNICATIONS, OUTSIDE PLANT (OSP), apply to this section with additions and modifications specified herein.

Contact Camp Lejeune Base Telephone (aka Telecommunications Support Division or TSD) for special requirements on classified service cabling and color, unofficial service, under slab cabling, using water block, and any item not covered in this document.

Buildings with Special Network Requirements such as Secured Internet Protocol, Classified networks, Commercial network, Charter cable, MCCS.org, Boingo, and Naval Blue Network may require additional guidance outside this specification. Secured areas or secured networks in non-secured areas may require Protected Distribution System (PDS) which is also outside this specification. Classified networks may require shielded twisted pair, distinct color, and has separation requirements outside this specification, and shall be in accordance with current CNSSAM TEMPEST RED/BLACK Installation documentation. In these cases contact Telecommunications Support Division G-6 MCIEAST-MCB CAMLEJ for additional guidance at (910) 451-9439 or (910) 451-4760.

Contact AHJ for special requirements on classified service, unofficial service, under slab cabling, using water block, and any item not covered in this document.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568.1, TIA-568.2, TIA-568.3, TIA-569, TIA-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) also known as central office or Area Distribution Node.)

1.3.2 Building Distributor (BD)

A distributor in which the building backbone (customer owned outside plant) cables terminate and at which connections to the campus backbone cables may be made. Typically a central location for terminating permanent backbone cables to interconnect with service provider (SP) equipment at the activity minimum point of presence. Generally includes specific components to support voice and data circuits, building surge protector

assemblies, main cross connect blocks, equipment support frames, and fire rated plywood backboard. (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. Usually within telecommunications rooms. Shall be connected to BD with both fiber and copper. A secure Internet Protocol (SIPR) vault or cabinet is considered an FD. (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) (can be within Main TR)

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)(can be within a TR/ CR)

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 an enclosed 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, such as wire basket tray, cable tray, J-hooks, D-rings, or bridal rings. D rings should only be used in the TR/CR for cable management and J-hooks/bridal rings shall not be used except in minor renovations where they exist already.

1.3.8 Open Office

A floor space division provided by furniture, moveable partitions, or other means instead of by building walls, normally over 100 square feet.

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, and other communications systems (including LAN. A/V,

intercom, PA, CATV, CCTB, and WiFi) 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 /BD /TR /ER 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 (Area Distribution Node) 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, current TIA-569, and MCB CL Base Telephone (TSD) guidance. The telecommunications contractor must coordinate with the MCB CL Base Telephone via Contracting or Construction Manager / Project Manager concerning access to and configuration of telecommunications spaces. The telecommunications contractor may be required to coordinate work effort within the telecommunications spaces with the electrical sub and general contractor, Resident Officer in Charge of Construction (ROICC) and MCB CL Base Telephone (TSD).

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications Drawings; G

Telecommunications Space Drawings; G

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

Patch Panels; G

Telecommunications Outlet/Connector Assemblies; G

Equipment Support Frame; G

Connector Blocks; G

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

SD-07 Certificates

Telecommunications Contractor Qualifications; G

Key Personnel Qualifications; G

Manufacturer Qualifications; G

Test Plan; G

SD-09 Manufacturer's Field Reports

Factory Reel Tests; G

SD-10 Operation and Maintenance Data

Telecommunications Cabling and Pathway System Data Package 5; G

SD-11 Closeout Submittals

Record Documentation; G

1.5.1 ADDITIONAL SUBMITTAL REQUIREMENTS

All submittals of material, equipment and design must be approved by the Telecommunications Support Division (TSD) prior to installing any telecommunications wiring, equipment, or power to support communications.

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, except as specified otherwise. 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-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-606. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the EF /BD telecommunications and ER /TR telecommunications, CD'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, dedicated electrical for communications equipment, 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, detail racking, and raceways.

1.6.1.2 Telecommunications Space Drawings

Provide T3 drawings in accordance with TIA-606 that include telecommunications rooms plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and cabinet, rack, 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, dedicated mechanical/electrical, patch panels and equipment spaces and cabinet/racks. Drawings shall include a complete list of equipment and material, equipment rack 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. IAW Section on QC Specialists; a Telecommunications Systems QC Specialist is required on site, full time with 10 years minimum experience in telecom installation and experience. Specialist shall be very familiar with UFGS Divisions 27, 28, 33 concerning communications systems work and installation.

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-568.1, TIA-568.2 and TIA-568.3.

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, sample report, 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 manufacturer recommendations, installation manual, best known industry practices, and industry standards, 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 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.

1.6.5.2 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 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 of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing. All telecommunications spaces shall follow TIA-569 design.

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. Also provide copies of all Telecommunications manuals to TSD.

1.10.2 Record Documentation

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA-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. Provide the following T5 drawing documentation as a minimum:

- a. Cables - A record of installed cable shall be provided in accordance with TIA-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-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-606. Documentation shall include the required data fields as a minimum in accordance with TIA-606.

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/racks. 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. Provide system furniture pathways in accordance with UL 1286.

2.2.1 PATHWAYS ABOARD CAMP LEJEUNE GREATER AREA, INCLUDING MCAS NEW RIVER

Pathway shall be conduit, cable tray, or modular access flooring that provides protection for cabling. Under floor duct, free laying, case work boxes, and wireway shall not be used. Cantilever-type center hung tray or Poke-Thru devices shall not be used. J-hooks/D-rings/bridal rings and other open face type cable pathways are not authorized except in minor renovations or to continue like existing system. Provide grounding and bonding as required by TIA-607. Cable tray wiring shall comply with NFPA 70. All conduits entering the communications room should be grouped and consolidated.

Individual conduits can be "Home Run" or stubbed to cable tray using approved pull boxes after every 180 degrees of bends, all shall have bonding bushing/plastic insert, and shall extend down from the ceiling to 3 to 4 inches onto the backboard, and will be bonded to the TMGB or TGB by a minimum number 6 green sheathed stranded conductors. All penetrations will be sealed in accordance with code (fire-stopping). A minimum of two 3 inch conduits will be installed overhead between the main communications room and other communication rooms, if installed below slab they are considered OSP and fall under Section 33 82 00 TELECOMMUNICATIONS, OUTSIDE PLANT (OSP). Distribution Enclosures shall not be used as a pull box and will only be approved for their intended use.

2.2.2 WORK AREA PATHWAYS

Comply with TIA-569, except minimum 1 1/4 inch diameter conduit will be used. Each work area outlet must have its own conduit to the comm room or nearest cable tray, multiple outlets cannot be ganged together except in a floor box, MUTOA, or system furniture. System furniture pathways shall comply with UL 1286. In system furniture that blocks access to or is distant from the communications wall outlets: each system furniture desk/cubical shall be equipped with system furniture communications outlets that are plugged into the communications wall outlets. All ports should be extended into the furniture.

2.2.3 TELEPHONE OUTLET BOXES

Communications outlet boxes shall be placed in all work areas and any areas that can be converted to work areas; so any furniture package configuration will have a connection with a 6' base cord. Recommended practice is 6" to the left or right of (the outside edge of) electrical outlet box in workable office areas or any area that could be converted into workable office area such as a large storage closet; also any conference room should have one floor box and one box just above the ceiling. Boxes shall be standard type 5 inches square by 2 7/8 inches deep for CAT6 with 1 1/4 inch diameter knock-outs, with a single gang plaster ring. Mount flush in finished walls or 3 to 12 inches above ceiling tile. Outlet boxes for wall-mounted telephones shall be 2 by 4 by 2-1/8 inches deep with 1 CAT6 cable terminated in a standard CAT6 studded wall phone plate; mounted at ADA required height. Outlet boxes for work counter area or case work shall be mounted through or above casework/counter, typically at a height 48 inches above finished floor. Outlet boxes installed for CCTV, Wireless access points, and CATV shall contain two CAT 6 cables. Outlet boxes should have their own individual conduit to the comm room or nearest cable tray. Outlets installed in floor shall be communications floor boxes large enough to support a surge of users with proper cable/ port protection and ports that are in multiples of 4. For raised access flooring, boxes shall be below the floor with an access cover flush with the floor. Tombstones above the floor or boxes below floor that require removal of the floor panels to access are not allowed. Floor boxes and under slab cabling should not be used in wet areas. Tele electric poles or furniture managed pathways fed from above the wet area should be used. Multi-user Telecommunications Outlet Assembly i.e. Multimedia Outlet Assemblies (MUTOA) should be placed where best suited for the furniture used in open office spaces and maintain a clearance more than 6" from electrical or 2nd MUTOA for proper operation.

2.3 TELECOMMUNICATIONS CABLING

Cabling shall be UL listed for the application and shall comply with TIA-568.0, TIA-568.1, TIA-568.2, TIA-568.3 and NFPA 70. Provide a labeling system in accordance with the manufacturer and local AHJ guidance for cabling as required by TIA-606 and UL 969. Confirm labeling is compatible with Base service provider requirements. 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 Copper

Copper backbone cable and riser shall be solid conductor, 24 AWG, 100 ohm, 100 -pair, Category 3, UTP, in accordance with ICEA S-90-661, TIA-568.1, TIA-568.2 and UL 444, formed into 25 pair binder groups covered with a gray thermoplastic jacket and overall metallic shield if required for additional protection. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular length marking intervals in accordance with ICEA S-90-661. Sufficient pair count of CAT 3 or 5, as required shall be installed between the MDF and each of the IDF's.

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. Any backbone copper run in under slab conduit shall be rated for outdoor use in accordance with AHJ and have lightning protection at both ends.

2.3.1.2 Backbone Optical Fiber

Provide in accordance with ICEA S-83-596, TIA-568.3, 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 12 strands between the main telecommunication rooms or secure racks/cabinets), 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 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.

2.3.2 Horizontal Cabling

Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568.1.

2.3.2.1 Horizontal Copper

Provide a minimum of four horizontal copper cables to each work area outlet (faceplate), UTP, 100 ohm in accordance with TIA-568.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661. Provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6 or higher, with a green thermoplastic jacket for all unclassified ports (color and cable type for classified services shall be in accordance with current CNSSAM TEMPEST RED/BLACK Installation documentation including Table 1 (below). 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. 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 are not recommended but can be used if approved by local AHJ and shall be UL listed and labeled for wet locations in accordance with NFPA 70. Contact AHJ for special requirements on classified service, under slab cabling, using water block, and any item not covered in this document.

Table 1 - (U/FOUO) Cable Color Scheme

Classification Level	Cable Color
Unclassified	Green
Collateral Confidential	Blue
Collateral Secret	Red
Collateral Top Secret	Orange
Special Category	Yellow

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 green on odd numbered and green on even numbered thermoplastic jacket for unclassified services (classified color code shall be in accordance with current CNSSAM TEMPEST RED/BLACK Installation documentation).

Communications CAT6 twisted pair shall have a minimum of 12 inch slack cable loosely coiled into the communications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded. All communications work area outlet boxes should have 4 cables to a double gang box (no rough in or empty conduit for future use allowed).

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-606.

Space shall be designed per TIA-569 section 6.4.4 Design, unless a local waiver is provided by the AHJ which is TSD aboard Camp Lejeune. Communications distribution room min 10'x10' but could be much larger depending on building size, usable square footage served, multiple networks, classified networks, and customer requirements. Communications rooms shall be centrally located unless there are multiple Communication rooms, and then each room should be centrally located within the area served. Communications Rooms shall not share or be on a wet wall. Generally, the space should be sized to approximately 1.1 percent of the area it serves. For example, a 10,000 sq feet (929 sq m) area should be

served by a minimum of one 10 ft x 11 ft (3 m x 3.4 m) Communications room. Access to Rooms shall be from a common area such as a hallway and door shall swing out.

Additional/Multiple communications rooms are required if the usable floor space to be served exceeds 10,000 square feet, or the cable length between the horizontal cross-connect and the communications outlet, including slack and vertical distance, exceeds 295 feet. Multiple communications rooms and IDFs shall be stacked and connected by a minimum of two 3 inch conduits overhead. If under slab it is considered Outside Plant and 3 way 4" shall be used per Section 33 82 00 TELECOMMUNICATIONS, OUTSIDE PLANT (OSP) with proper surge protection at both ends.

The minimum clear height in the room shall be 2.4 m (8 ft) without obstructions. The height between the finished floor and the lowest point of the ceiling should be a minimum of 3 m (10 ft) to accommodate overhead pathways. The flooring shall be sealed concrete or Electro Static Dissipating flooring to reduce dust and static electricity; no carpet or VCT tile.

Two separate dedicated 20 amp electrical circuits in one quadruplex outlet and one 30 amp will be installed above / behind but not attached to each communications equipment rack. Vertical Power Distribution Units should be plugged into the dedicated power and mounted to the back side of the telecomm racks/ cabinets.

OSP conduits and other telecomm equipment shall on the longest furthest wall from the door and to the far left of the communications backboard while facing it (behind the racks). There should not be an electrical panel within the communications room unless it serves only the room, and it should be located as close to the door as possible. The room requires a lockable door keyed or key padded to restrict access to MCIEAST-MCB G-6 personnel only. Room shall not have any windows or skylights. At least one wall, where the point of presence is located, and two adjacent walls should be covered with fire rated plywood backboard for mounting equipment; additional boards may be needed for mounting additional equipment.

Light, as measured within the communications room, should be a minimum of 500 lux (50 foot-candles). Lighting design should seek to minimize shadows within the telecommunications room (minimum two light fixtures). Equipment not related to the support of the communications room (e.g., piping, ductwork, pneumatic tubing) shall not be installed in, pass through, or enter the telecommunications room.

Equipment related to the support of the communications room (e.g., piping, ductwork, HVAC drains, and dedicated power) shall be installed in support of the communications equipment and not pose a drip/moisture/trip hazard and be usable as intended.

2.4.1 Backboards

Provide void-free, interior grade A-C plywood 3/4 inch thick 4 by 8 feet as indicated. Fire stamp shall be clearly visible. Backboards shall be provided on the longest furthest wall from the door and a minimum of two adjacent walls, and anywhere mounting is needed in the telecommunication spaces.

2.4.2 Equipment Support Frame

Provide in accordance with ECIA EIA/ECA 310-E and UL 50. Steel construction shall be treated to resist corrosion.

- a. Bracket, wall mounted, 8 gauge aluminum (for buildings with very low jack/pair count and no secured electronic equipment requirement). Provide hinged bracket compatible with 482.6 mm 19 inches panel mounting (must be in a secured room).
- b. Racks, wall or floor mounted modular type, 16 gauge steel or 11 gauge aluminum construction, minimum, treated to resist corrosion. Provide rack with vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, with surge protected power strips for dedicated power 20/30 amp receptacles. Racks shall be large enough to support all telephone/data equipment required plus 25 percent spare and shall have a maximum of 7' height. Rack shall be compatible with 482.6 mm 19 inches panel mounting and must be in a secured communications room.
- c. Cabinets, freestanding modular type, 16 gauge steel or 11 gauge aluminum construction, minimum, treated to resist corrosion. Cabinet shall have removable and lockable side panels, front and rear doors, and have adjustable feet for leveling. All cabinets shall be keyed to current TSD key and large enough to support all telephone/data equipment required in the building plus 25% for future expansion. A backboard for mounting equipment is still needed when a cabinet is installed. Cabinet shall be mounted to the far right of the board to allow space for OSP cable, lightning protection, and bus bar to be installed on the board's far left. Dedicated power shall be within the cabinet and on the backboard. Cabinet shall be vented in the roof and rear door. Cabinet shall have cable access in the roof and base and be compatible with 482.6 mm 19 inches panel mounting. Provide cabinet with grounding bar rack mounted 15 cu. m 550 CFM fan with filter and a surge protected power strips with 20/30 amp receptacles.
- d. Cabinets, wall-mounted modular type, 16 gauge steel or 11 gauge aluminum construction, minimum, treated to resist corrosion. Cabinet shall have a lockable front and rear doors, louvered side panels, 7 cu. m 250 CFM rack mounted fan, ground lug, and top and bottom cable access. Cabinets shall be no smaller than 24"W X 48"H X 30"D, shall be keyed to current TSD key, and large enough to support all telephone/data equipment required in the building plus 25% for future expansion. Dedicated electrical outlets should be installed within the cabinet. A backboard for mounting equipment is still needed when a cabinet is installed. Cabinet shall be mounted to the far right of the board to allow space for OSP cable, lightning protection, and bus bar to be installed on the board's far left. Cabinet shall be compatible with 482.6 mm 19 inches panel mounting. All cabinets shall be keyed alike. A duplex AC outletsurge 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, 50 pair, rack

mounted blocks, compatible with industry standard 110 blade punch down tool, designed for Category 3 and higher systems. Provide blocks for the number of horizontal and backbone cables terminated on the block plus 25 percent spare. Also provide sufficient blocks for cross connects to all IDFs.

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 racks and telecommunications backboards. Cable guides of ring or bracket type devices mounted on rack panels/backboard for horizontal cable management and individually mounted for vertical cable management. Mount cable guides with screws, and or nuts and lockwashers. Cable guides are not to be used outside of the communications room.

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 of various appropriate lengths and as complete assemblies, with matching connectors as specified. Provide fiber optic patch cables with crossover orientation in accordance with TIA-568.3. Patch cords shall meet minimum performance requirements specified in TIA-568.1, TIA-568.2 and TIA-568.3 for cables, cable length and hardware specified. Classified service may require shielded jack sets and panels as approved by AHJ.

2.4.5.1 Modular to 110 Block Patch Panel

Provide in accordance with TIA-568.1 and TIA-568.2. 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 rack mounted and compatible with an ECIA EIA/ECA 310-E 19 inches equipment rack. 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 rack mounted and compatible with a ECIA EIA/ECA 310-E 19 inches equipment rack. Each panel shall provide 12 single-mode adapters as duplex SC in accordance with TIA/EIA-604-3 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. When populating the panel working left to right start with OSP feed, SM ISO to IDF, MM ISO to IDF, lastly row to row within same comm room.

2.4.6 Optical Fiber Distribution Panel

Rack mounted optical fiber distribution panel (OFDP) shall be constructed

in accordance with [ECIA EIA/ECA 310-E](#) 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 12 single-mode pigtails and adapters. Provide adapters as duplex SC 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-568.1](#), and [TIA-568.2](#). 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-568.2](#) Category 6 requirements. Outlet/connectors provided for UTP cabling shall meet or exceed the requirements for the cable provided and have the capability to be installed from the front or rear of the faceplate/patch panel.

Outlet/connectors shall be terminated using a standard IDC connector, color-coded for both [TIA-568A](#) and [TIA-568B](#) wiring. Each outlet/connector shall be wired T568A. UTP/STP outlet/connectors shall comply with [TIA-568.2](#) for 750 mating cycles.

2.5.2 Cover Plates

Telecommunications cover plates shall comply with [UL 514C](#), and [TIA-568.1](#), [TIA-568.2](#), ; flush design constructed of high impact thermoplastic material to match color of receptacle/switch cover plates specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Additionally, it shall be labeled as to its function and color coded (color code shall be in accordance with current CNSSAM TEMPEST RED/BLACK Installation documentation). Provide labeling in accordance with the paragraph LABELING in this section.

2.6 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-606](#).

2.7 GROUNDING AND BONDING PRODUCTS

Provide in accordance with [UL 467](#), [TIA-607](#), and [NFPA 70](#). Components shall be identified as required by [TIA-606](#). Provide ground rods, bonding conductors, and grounding busbars as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. The preferred ground for the Telephone Main Grounding Bus (TMGB) bar will be to the Main electrical Distribution Panel (MDP) bus bar and building steel. In most cases, but not all; a #6 AWG bonding conductor is recommended for telecommunications. All grounding and bonding conductors within the Telecommunications room will be green sheathed copper conductor, stranded, and labeled as suitable for use as such and tagged "DO NOT REMOVE". All grounding and bonding conductors running out of the Telecommunications room should be protected in conduit

or attached to the outside of the cable tray and sized according to references.

The minimum size of the TMGB shall be no smaller than 4" by 10" (could be much longer as needed) by 1/4 inch thick; bus bar should be factory made and factory drilled, not fabricated or drilled onsite. All bonding and grounding terminations shall be irreversible and secured with a double hole crimp termination. Do not exceed minimum bend radius on bonding and grounding conductors. Do not put bonding conductors in conduit and on backboard (should be on backboard OR in conduit, not both). Mount Bus Bar to far left of telecomm backboard at approximately 60-70" AFF.

2.8 FIRESTOPPING MATERIAL

Provide as specified in Section 07 84 00 FIRESTOPPING.

2.9 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.

2.10 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.

2.11 TESTS, INSPECTIONS, AND VERIFICATIONS

2.11.1 Factory Reel Tests

Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with TIA-568.1, TIA-568.2, TIA-568.3, 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-568.1, TIA-568.2, TIA-568.3, TIA-569, NFPA 70, manufacturer instructions, current industry best practices, local guidance, and UL standards as applicable (except 1-1/4" conduit should be used for individual WAO).

Provide cabling in a star topology network. Pathways and outlet boxes shall be installed as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and local guidance. Standard type 5" x 5" x 2 7/8" square box with a single gang plaster ring shall be used except in concrete or concrete masonry units (CMU) or in slab where a standard 4 11/16" square or a floor

box will be used. Mount flush in finished walls at height indicated by drawings and with proper clearances from other networks and power systems. Depth of boxes shall be large enough to allow manufacturer's recommended conductor bend radii, normally 2 7/8" depth.

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. (normal minimum clearance distances of 4 feet from motors, generators, frequency converters, transformers, x-ray equipment or uninterrupted power system, 300 mm (12 in) from power conduits and cable systems, 125 mm (5 inches) from fluorescent or high frequency lighting system fixtures). Cabling shall be run with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

3.1.1.1 Cabling

Install UTP, and optical fiber telecommunications cabling system as detailed in TIA-568.1, TIA-568.2, TIA-568.3. 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 untwist Category 6 cables more than ½" (12 mm) from the point of termination to maintain cable geometry. Provide service loop on each end of the cable, minimum 10' (3 meters) in the telecommunications room, 6" (150mm) in or close to the work area outlet.

Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 110 N (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. Only hook and loop fasteners are allowed on Category 6/6A cable and optical fiber cable. DO NOT USE ZIP TIES.

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 (see NFPA 70 abandoned cabling). Category 6/6A Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

3.1.1.1.1 Open Cable

Use only where specifically indicated on plans (typically to continue existing systems in a renovation or in interim facilities) or use cable trays, or below raised floors in an approved pathway (free aired or free laid cabling is not authorized). Install in accordance with TIA-568.1, TIA-568.2 and TIA-568.3. Do not exceed cable pull tensions recommended by the manufacturer. Copper cable not in a wireway or pathway 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.

Plenum cable shall be used where open cables are routed through plenum areas. Cable routed exposed under raised floors shall be plenum rated. Plenum cables shall comply with flammability plenum requirements of NFPA 70. Install cabling after the flooring system has been installed in raised floor areas. 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. Copper Backbone Cable. Install intrabuilding backbone copper cable, in minimum 2-way 3 inch conduit or larger indicated pathways, between the campus distributor, located in the telecommunications entrance facility or room, the building distributors and the floor distributors located in telecommunications rooms and telecommunications equipment rooms as indicated on drawings.
- b. Optical fiber Backbone Cable. Install intrabuilding backbone optical fiber in one of multiple interducts installed in conduit so as to maximize pathways, in indicated pathways, between various communications rooms and between racks of different classifications within the same room. 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.

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, except that 1-1/4 inch diameter conduit from cable tray or telecommunication room backboard to each work area outlet is required.

Conceal conduit within finished walls, ceilings, and floors (not in wet areas). Keep conduit minimum 12 inches away from parallel runs of electrical power equipment, flues, steam, light ballast, and 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 is visible after completion of project. Run conduits in crawl spaces as if exposed.

Install no more than two 90 degree bends for a single horizontal cable run. All bends/turns in conduits will be in straight runs of conduit; a pull box shall be installed after every 180 degrees of bends or 100'; in no case will a turn be made within a pull box. The minimum size for a pull box for a single 1 1/4" conduit will be 5" long by 5" wide by 2 7/8" deep, and for a 3" conduit 30"W x 54"L x 9"D. All conduits should contain a bushing at the end to protect the cable from damage and required

bonding. Pull points, LC, LB, condulets, and consolidation points are not authorized without a waiver from TSD.

Under floor cabling, under floor duct, and conduit under floor slabs should be avoided in the Camp Lejeune Greater area due to wet area close to coastal waters.

3.1.3 Service Entrance Conduit, Underground

Provide service entrance underground as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Underground portion shall be encased in minimum of 3 inches of concrete extending from the building entrance to OSP demarcation point and shall be a minimum of 18 inches below slab or grade. Location of entrance conduit in communications room shall be to the left, while facing the longest furthest wall from the door.

3.1.4 Cable Tray Installation

Install cable tray as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Only CMP and OFNP type cable shall be installed in a plenum.

A continuous stranded bonding conductor (typically copper #2awg) shall be run on the outside along the tray tapped to each section properly to ensure bonding. Remove all sharps from cable tray and pathways. Ensure bonding is on the pathway so as not to obstruct horizontal cabling. Maintain proper clearance and work space per TIA-569 and TEMPEST.

3.1.5 Work Area Outlets

3.1.5.1 Terminations

Terminate UTP cable in accordance with TIA-568.1, TIA-568.2 and wiring configuration as specified.

All private office (less than 80 sq ft) work areas will contain a minimum of two communications face plates. Any work area larger than 80 sq feet will require additional face plates to service any work location in the room within 6 feet of a faceplate. This also applies to any area that could be converted to work space in the future. Recommend a communications outlet box be placed 6" to the left or right of electrical outlet box in workable office areas or any area that could be converted into workable office area such as a storage closet; All work area face plates will contain four jacks/ four cables terminated with T568A configuration unless otherwise approved by AHJ. MUTOAs contain 12 cables and may require additional clearance and power.

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. For secured networks contact AHJ as shielded twisted pair and color coded face plates may be necessary.

3.1.5.3 Cables

Unshielded / Shielded twisted pair and fiber optic cables shall have a minimum of 12 inches of slack cable loosely coiled into the telecommunications outlet boxes or in cable tray as close as possible to outlet box. 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.

3.1.6 Telecommunications Space Termination

Install termination hardware required for Category 6 and optical fiber system. A single punch manufacture approved insulation displacement tool shall be used for terminating copper cable to insulation displacement connectors.

3.1.6.1 Connector Blocks

Connector blocks shall be rackwall 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 racks 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 with cable ties 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 provided as recommended by the manufacturer. The outer jacket of each cable entering a patch panel shall be secured to the panel per manufacture instructions 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 rack so height of highest panel does not exceed 78 inches above floor. Mount so there is sufficient space remaining on backboard to mount lightning protection, bonding, and cable managers or install additional backboards.
- b. Racks, floor mounted modular type. Permanently anchor rack to the floor in accordance with manufacturer's recommendations. Install sections of ladder rack anchored to telephone rack/cabinet and at least two walls.
- c. Cabinets, freestanding modular type. Permanently anchor to the floor in accordance with manufacturer's recommendations. When cabinets are connected together, remove adjoining side panels for cable routing between cabinets. Mount rack mounted fan in roofbase of cabinet and 19" power/surge strip in cabinet. Install sections of ladder rack anchored to telephone rack/cabinet and at least two walls.

- d. Cabinets, wall-mounted modular type. Mount cabinet to right on plywood backboard in accordance with manufacturer's recommendations. Mount cabinet so height of highest panel does not exceed 78 inches above floor. Mount so there is sufficient space remaining on backboard to mount lightning protection, bonding, and cable managers or install additional backboards.

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 except only two hole irreversible compression lugs will be accepted.

3.2 LABELING

3.2.1 Labels

Provide labeling in accordance with TIA-606, except jacks will be numbered in a logical, sequential, clockwise numbering system from 1 to X with a closet designator. Example would be 145 C 146, would be the 145th & 146th jacks from the C telecom room. All labels shall be numbered with manufacturer's labeling system (not fabricated) and be equipped with laminated plastic cover.

All terminations that are not to work area outlets should be in the last patch panel locations and labeled accordingly i.e. DDC, FACP, Elevator, Wall phones, or Wireless access points. 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-606.

3.2.3 Termination Hardware

Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with this section and TIA-606. Coordinate with TSD (Base Telephone).

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

Camp Lejeune no longer paints backboards as fire rated plywood is available. Manufactured fire retardant backboard shall be used, so as not to increase flame spread and smoke density and must be appropriately

labeled.

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 on both Backbone and Horizontal cabling in accordance with TIA-568.1, TIA-568.2, TIA-568.3 and AHJ local guidance. 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 all telecommunications cabling 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-568.1, TIA-568.2, TIA-568.3, . Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, cable physical damage, and patch panels.

3.5.1.2 Verification Tests

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.

3.5.1.3 Performance Tests

Provide summary in.pdf detailed tester results in test format .flw , and fiber power meter/OTDR reports summary and detailed. All Test reports should have a building or project number on each page. The final QC and certification of installation will be performed by TSD after the contractor has provided passing and acceptable results on all test and as-built drawings showing all telecommunications outlets and their numbers to include any empty conduit or ports coiled in overhead for future use and all building automated system ports such as DDC, Elevator, FACP, or WAPs.

Test results that are marginal may not be accepted. Also fiber tests that pass the link budget but exceed tolerance on any connector or splice are considered a failure. All discrepancies must be repaired and retested.

Perform testing for each outlet and MUTOA as follows:

- a. Perform Category 6 link tests in accordance with TIA-568.1 and

TIA-568.2. 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-568.3.

3.5.1.4 Final Verification Tests

Perform verification tests for all copper 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 (normally done for FACP, Elevator, or emergency phones). 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 (normally done for VTC, CCTV). Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

-- End of Section --

SECTION 28 31 76

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE
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.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2 (2020) American National Standard 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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4 (2018) Standard for Integrated Fire
Protection and Life Safety System Testing

NFPA 70 (2023) National Electrical Code

NFPA 72 (2022; ERTA 22-1) National Fire Alarm and
Signaling Code

NFPA 90A (2021) Standard for the Installation of
Air Conditioning and Ventilating Systems

NFPA 170 (2021) Standard for Fire Safety and
Emergency Symbols

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-601-02 (2021) Fire Protection Systems Inspection,
Testing, and Maintenance

UFC 4-010-06 (2016; with Change 1, 2017) Cybersecurity
of Facility-Related Control Systems

UNDERWRITERS LABORATORIES (UL)

UL 268	(2016; Reprint Nov 2021) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; Reprint Oct 2014) Smoke Detectors for Duct Application
UL 464	(2016; Reprint Sep 2017) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 864	(2014; Reprint May 2020) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL 1283	(2017) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021) UL Standard for Safety Surge Protective Devices
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 Dec 2018) UL Standard for Safety General-Purpose Signaling Devices and Systems
UL 2034	(2017; Reprint Apr 2022) UL Standard for Safety Single and Multiple Station Carbon Monoxide Alarms
UL 2075	(2013; Bul. 2019) UL Standard for Safety Gas and Vapor Detectors and Sensors
UL 2572	(2016; Bul. 2018) UL Standard for Safety Mass Notification Systems
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 RELATED SECTIONS

Section 25 05 11 Cybersecurity for Facility-Related Control Systems, 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 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION

Section 07 84 00 FIRESTOPPING for additional work related to firestopping.

1.3 SUMMARY

1.3.1 Scope

- a. This work includes designing and providing a new, complete, fire alarm and mass notification (MNS) system as described herein and on the contract drawings. Include system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, initiating devices, notification appliances, supervising station fire alarm transmitters/mass notification transceiver, and other accessories and miscellaneous items required for a complete operational system even though each item is not specifically mentioned or described. Provide system complete and ready for operation. Design and installation must comply with UFGS 25 05 11, UFC 4-010-06 and AFGM 2019-320-02.
- b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with NFPA 72, except as modified herein. The system layout on the drawings show the intent of coverage and suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor.
- c. The fire alarm and mass notification system must be independent of the building security, building management, and energy/utility monitoring systems other than for control functions.

1.3.2 Qualified Fire Protection Engineer (QFPE)

Services of the QFPE must include:

- a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Construction (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.
- b. Providing a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting any outstanding comments.
- c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).
- d. Witnessing pre-Government and final Government functional performance

testing and performing a final installation review.

- e. Signing applicable certificates under SD-07.

1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions must 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 Fire Alarm and Mass Notification Control Unit (FMCU)

A master control unit having the features of a fire alarm control unit (FACU) and an autonomous control unit (ACU) where these units are interconnected to function as a combined fire alarm/mass notification system. The FACU and ACU functions may be contained in a single cabinet or in independent, interconnected, and co-located cabinets.

1.4.3 Remote Fire Alarm and Mass Notification Control Unit

A control unit, physically remote from the fire alarm and mass notification control unit, 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 and mass notification control unit.

1.4.4 Local Operating Console (LOC)

A unit designed to allow emergency responders and/or building occupants to operate the MNS including delivery of recorded messages and/or live voice announcements, initiate visual, textual visual, and audible appliance operation and other relayed functions.

1.4.5 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door where terminal strips are securely mounted inside the cabinet.

1.4.6 Control Module and Relay Module

Terms utilized to describe emergency control function interface devices as defined by NFPA 72.

1.4.7 Designated Fire Protection Engineer (DFPE)

The DoD fire protection engineer that oversees that Area of Responsibility for that project. This is sometimes referred to as the "cognizant" fire protection engineer. Interpret reference to "authority having jurisdiction" and/or AHJ in referenced standards to mean the Designated Fire Protection Engineer (DFPE). The DFPE may be responsible for review of the contractor submittals having a "G" designation, and for witnessing final inspection and testing.

1.4.8 Qualified Fire Protection Engineer (QFPE)

A QFPE is an individual who is a licensed professional engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience.

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 Contractor Quality Control approval.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the fire alarm designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their registered professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE will be returned by the Government disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G

Fire alarm system designer; G

Supervisor; G

Technician; G

Installer; G

Test Technician; G

Fire Alarm System Site-Specific Software Acknowledgement; G

SD-02 Shop Drawings

Nameplates; G

Instructions; G

Wiring Diagrams; G

System Layout; G

Notification Appliances; G

Initiating devices; G

Amplifiers; G

Battery Power; G

Voltage Drop Calculations; G

SD-03 Product Data

Fire Alarm and Mass Notification Control Unit (FMCU); G

Local Operating Console (LOC); G

Amplifiers; G

Tone Generators; G

Digitalized voice generators; G

LCD Annunciator; G

Manual Stations; G

Smoke Detectors; G

Duct Smoke Detectors; G

Carbon monoxide detector; G

Addressable Interface Devices; G

Addressable Control Modules; G

Notification Appliances; G

Batteries; G

Battery Chargers; G

Supplemental Notification Appliance Circuit Panels; G

Auxiliary Power Supply Panels; G

Surge Protective Devices; G

Alarm Wiring; G

Back Boxes and Conduit; G

Ceiling Bridges for Ceiling-Mounted Appliances; G

Terminal Cabinets; G Digital Alarm Communicator Transmitter (DACT; G

Mass Notification Transceiver; G Environmental Enclosures or Guards;
G

Document Storage Cabinet; G

SD-06 Test Reports

Test Procedures; G

SD-07 Certificates

Verification of Compliant Installation; G

Request for Government Final Test; G

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G

Instruction of Government Employees; G

SD-11 Closeout Submittals

As-Built Drawings

Spare Parts

1.6 SYSTEM OPERATION

Fire alarm system/mass notification system, components requiring power, except for the FMCU(s) power supply, must operate on 24 volts DC unless noted otherwise in this section.

The interior fire alarm and mass notification system must be a complete, supervised, noncoded, analog/addressable fire alarm and mass notification system conforming to NFPA 72, UL 864, and UL 2572. Systems meeting UL 2017 only are not acceptable. The system must be activated into the alarm mode by actuation of an alarm initiating device. The system must remain in the alarm mode until the initiating device is reset and the control unit is reset and restored to normal. The system may be placed in the alarm mode by local microphones, LOC, FMCU, or remotely from authorized locations/users.

1.6.1 Alarm Initiating Devices and Notification Appliances (Visual, Voice, Textual)

- a. Connect alarm initiating devices to initiating device circuits (IDC) Class "B", or to signaling line circuits (SLC) Class "B" and installed in accordance with NFPA 72.
- b. Connect notification appliances to notification appliance circuits (NAC) Class "B".

1.6.2 Functions and Operating Features

The system must provide the following functions and operating features:

- a. Power, annunciation, supervision, and control for the system. Addressable systems must be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.
- b. Visual alarm notification appliances must be synchronized as required by NFPA 72.
- c. Electrical supervision of the primary power (AC) supply, presence of

the battery, battery voltage, and placement of system modules within the control unit.

- d. An audible and visual trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal must also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory control unit modules. After the system returns to normal operating conditions, the trouble signal must again sound until the trouble is acknowledged. A smoke detector in the process of being verified for the actual presence of smoke must not initiate a trouble condition.
- e. A trouble signal silence feature that must silence the audible trouble signal, without affecting the visual indicator.
- f. Program capability via switches in a locked portion of the FMCU to bypass the automatic notification appliance circuits, fire reporting system and air handler shutdown features. Operation of this programmed action must indicate on the FMCU display as a supervisory or trouble condition.
- g. Alarm functions must override trouble or supervisory functions. Supervisory functions must override trouble functions.
- h. The system must be capable of being programmed from the control unit keyboard. Programmed information must be stored in non-volatile memory.
- i. The system must be capable of operating, supervising, and/or monitoring non-addressable alarm and supervisory devices.
- j. There must be no limit, other than maximum system capacity, as to the number of addressable devices that may be in alarm simultaneously.
- k. Where the fire alarm/mass notification system is responsible for initiating an action in another emergency control device or system, such as HVAC, the addressable fire alarm relay must be located in the vicinity of the emergency control device.
- l. An alarm signal must automatically initiate the following functions:
 - (1) Transmission of an alarm signal to the fire department using Contact ID Protocol.
 - (2) Visual indication of the device operated on the FMCU, and on the remote annunciator.
 - (3) Actuation of alarm notification appliances.
 - (4) Recording of the event electronically in the history log of the FMCU.
- m. A supervisory signal must automatically initiate the following functions:
 - (1) Visual indication of the device operated on the FMCU, and on the remote annunciator.
 - (2) Transmission of a supervisory signal to the fire department using

Contact ID Protocol.

- (3) Operation of a duct smoke detector must 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.
 - (4) Recording of the event electronically in the history log of the FMCU.
- n. A trouble condition must automatically initiate the following functions:
- (1) Visual indication of the device operated on the FMCU, and on the remote annunciator.
 - (2) Transmission of a trouble signal to the fire department using Contact ID Protocol.
 - (3) Recording of the event electronically in the history log of the FMCU.
- o. Activation of a carbon monoxide alarm initiating device must automatically initiate the following functions:
- (1) Visual indication of the device operated on the FMCU and on the remote annunciator.
 - (2) Transmission of a carbon monoxide alarm signal to the fire department using Contact ID Protocol.
 - (3) Activation of all strobes and the audible carbon monoxide message throughout the building.
 - (4) Recording of the event electronically in the history log of the FMCU.
- p. System control equipment must be programmed to provide a 60-minute to 180-minute delay in transmission of trouble signals resulting from primary power failure.
- q. Activation of a LOC pushbutton must activate the audible and visual alarms in the facility. The audible message must be the one associated with the pushbutton activated.

1.7 TECHNICAL DATA AND SITE-SPECIFIC SOFTWARE

Technical data and site-specific software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be required in other specifications, must be delivered, strictly in accordance with the CONTRACT CLAUSES. The fire alarm system manufacturer must submit written confirmation of this contract provision as "Fire Alarm System Site-Specific Software Acknowledgement". Identify data delivered by reference to the specification paragraph against which it is furnished. Data to be submitted must include complete system, equipment, and software descriptions. Descriptions must show how the equipment will operate as a system to meet the performance requirements of this contract. The site-specific software data package must also include the following:

- a. Items identified in NFPA 72, titled "Site-Specific Software".
- b. Identification of programmable portions of the system equipment and capabilities.
- c. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.
- d. Provision of operational software data on all modes of programmable portions for fire alarm and mass notification.
- e. Description of Fire Alarm and Mass Notification Control Unit equipment operation.
- f. Description of auxiliary and remote equipment operations.
- g. Library of application software.
- h. Operation and maintenance manuals.

1.8 EXISTING EQUIPMENT

- a. Equipment and devices must be compatible and operable with the existing supervising station and must not impair reliability or operational functions of existing supervising station fire alarm system. The supervising equipment is existing and consists of the following brand and model: Sur-Gard System III Multi-Platform Digital Telephone Receiver..
- b. Equipment and devices must be compatible and operable with the existing installation-wide mass notification system and must not impair reliability or operational functions of the existing system. The installation-wide mass notification system utilizes WAVES TRX-401 and SIRCOM ISU-118, VHF transceivers.

1.9 QUALITY ASSURANCE

1.9.1 Submittal Documents

1.9.1.1 Preconstruction Submittals

Within 36 days of contract award but not less than 14 days prior to commencing any work on site, the Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications of the fire alarm subcontractor and QFPE must be returned disapproved without review. All resultant delays must be the sole responsibility of the Contractor.

1.9.1.2 Shop Drawings

Shop drawings must not be smaller than the Contract Drawings. Drawings must comply with the requirements of NFPA 72 and NFPA 170. Minimum scale for floor plans must be 1/8"=1'.

1.9.1.3 Nameplates

Nameplate illustrations and data to obtain approval by the Contracting Officer before installation.

1.9.1.4 Wiring Diagrams

One copy of 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 must show connections from field devices to the FMCU and remote FMCU, initiating circuits, switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

1.9.1.5 System Layout

One copy of plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors. Indicate candela rating of each visual notification appliance. Indicate the wattage of each speaker. Clearly identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, and similar. Show/identify all acoustically similar spaces. Indicate if the environment for the FMCU is within its environmental listing (e.g. temperature/humidity).

Provide a complete description of the system operation in matrix format similar to the "Typical Input/Output Matrix" included in the Annex of NFPA 72.

1.9.1.6 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

1.9.1.7 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.9.1.8 Amplifiers

Calculations and supporting data to indicate that amplifiers have sufficient capacity to simultaneously drive all notification speakers at tapped settings plus 25 percent spare capacity. Annotate data for each circuit on the drawings.

1.9.1.9 Battery Power

Calculations and supporting data as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.9.1.10 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.9.1.11 Product Data

One copy of annotated descriptive data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, and options that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

1.9.1.12 Operation and Maintenance (O&M) Instructions

Six copies of the Operation and Maintenance Instructions. The O&M Instructions must be prepared in a single volume or in multiple volumes, with each volume indexed, and may be submitted as a Technical Data Package. Manuals must be approved prior to training. The Interior Fire Alarm And Mass Notification System Operation and Maintenance Instructions must include the following:

- a. "Manufacturer Data Package five" 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 must include the manufacturer's name, model number, service manual, parts list, and preliminary equipment list complete with description of equipment and their basic operating features.
- c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals must include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.
- d. Complete procedures for system revision and expansion, detailing both equipment and software requirements.
- e. Software submitted for this project on CD/DVD media utilized.
- f. Printouts of configuration settings for all devices.
- g. Routine maintenance checklist. The routine maintenance checklist must be arranged in a columnar format. The first column must list all installed devices, the second column must state the maintenance activity or state no maintenance required, the third column must state the frequency of the maintenance activity, and the fourth column provided for additional comments or reference. All data (devices,

testing frequencies, and similar) must comply with [UFC 3-601-02](#).

- h. A final Equipment List must be submitted with the Operating and Maintenance (O&M) manual.

1.9.1.13 [As-Built Drawings](#)

The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. [A bill of material and Contact ID Point Description Table must be included on the as-built drawings.](#) These drawings must be submitted within two weeks after the final Government test of the system. At least one set of the as-built (marked-up) drawings must be provided at the time of, or prior to the final Government test.

1.9.2 [Qualifications](#)

1.9.2.1 [Fire Alarm System Designer](#)

The fire alarm system designer must be certified as a Level IV (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology or meet the qualifications for a QFPE.

1.9.2.2 [Supervisor](#)

A NICET Level IV fire alarm technician must supervise the installation of the fire alarm/mass notification system. The fire alarm technicians supervising the installation of equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.9.2.3 [Technician](#)

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.9.2.4 [Installer](#)

Fire alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm/mass notification devices, cabinets and control units. A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the fire alarm system/mass notification system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.9.2.5 [Test Technician](#)

Fire alarm technicians with a minimum of eight years of experience and NICET Level IV utilized in testing and certification of the installation of the fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians testing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment installed as part of this project.

1.9.2.6 Manufacturer

Components must be of current design and must 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 specified herein.

1.9.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation must be considered as mandatory requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.11 MAINTENANCE

1.11.1 Spare Parts

Furnish the following spare parts in the manufacturers original unopened containers:

- a. Five complete sets of system keys.
- b. One manual stations.
- c. Two of each type of detector base and head installed.
- d. Two of each type of audible and visual alarm device installed.
- e. Two of each type of addressable monitor module installed.
- f. Two of each type of addressable control module installed.
- g. Two low voltage, one telephone, and one 120 VAC surge protective device.

1.11.2 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment must be furnished to the Contracting Officer, prior to the instruction of Government employees.

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENT

All fire alarm and mass notification equipment must be listed for use

under the applicable reference standards. Interfacing of UL 864 or similar approved industry listing with Mass Notification equipment listed to UL 2572 must be done in a laboratory listed configuration, if the software programming features cannot provide a listed interface control.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory and listed 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 must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening.

2.2.2 Nameplates

Major components of equipment must 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 name plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FMCU

Nameplates must be etched metal or plastic, permanently attached by screws to control units or adjacent walls.

2.2.3 Keys

Keys and locks for equipment, control units and devices must be identical. Master all keys and locks to a single key as required by the Installation Fire Department.

2.2.4 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 FMCU. The card must 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 must also include procedures for operating live voice microphones. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.3 FIRE ALARM AND MASS NOTIFICATION CONTROL UNIT

Provide a complete fire alarm and mass notification control unit (FMCU) fully enclosed in a lockable steel cabinet as specified herein. Operations required for testing or for normal care, maintenance, and use of the system must be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control unit, the unit cabinets must match exactly. The system must 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, relays for output function actuation.

- a. Each control unit must 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 must be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each control unit with supervisory functions for power failure, internal component placement, and operation.
- b. Visual indication of alarm, supervisory, or trouble initiation on the FMCU must be by liquid crystal display or similar means with a minimum of 80 characters. The mass notification control unit must have the capability of temporarily deactivate the fire alarm audible notification appliances while delivering voice messages.
- c. Provide secure operator console for initiating recorded messages, strobes and displays; and for delivering live voice messages. Provide capacity for at least eight prerecorded messages. Provide the ability to automatically repeat prerecorded messages. Provide a secure microphone for delivering live messages. Provide adequate discrete outputs to temporarily deactivate fire alarm audible notification, initiate/synchronize strobes and initiate textual visual notification appliances. Provide a complete set of self-diagnostics for controller and appliance network. Provide local diagnostic information display and local diagnostic information and system event log file.

2.3.1 Cabinet

Install control unit components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions. The enclosure must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must say "Fire Alarm and Mass Notification control unit" and must not be less than 1-inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches.

2.3.2 Silencing Switches

2.3.2.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FMCU that must silence the audible and visual notification appliances. Subsequent activation of initiating devices must cause the notification appliances to re-activate.

2.3.2.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch(es) that must silence the audible trouble and supervisory signal(s), but not extinguish the visual indicator. This switch must be overridden upon activation of a subsequent supervisory or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated if the supervisory or trouble condition still exists.

2.3.3 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. Initiating devices must be manually reset by switch from the FMCU after the initiating device or devices have been restored to normal.

2.3.4 Audible Notification System

The Audible Notification System must comply with the requirements of **NFPA 72** for Emergency Voice/Alarm Communications System requirements, except as specified herein. The system must be a one-way, multi-channel voice notification system incorporating user selectability of a minimum eight distinct sounds for tone signaling, and the incorporation of a voice module for delivery of recorded messages. Audible appliances must produce a three-pulse temporal pattern for three cycles followed by a voice message that is repeated until the control unit is reset or silenced. For carbon monoxide detector activation, audible appliances must produce a four-pulse temporal pattern for three cycles followed by a voice message that is repeated until the control unit is reset or silenced. Automatic messages must be broadcast through speakers throughout the building/facility but not in stairs or elevator cabs. A live voice message must override the automatic audible output through use of a microphone input at the control unit or the LOC.

- a. When using the microphone, live messages must be broadcast throughout a selected floor or floors, or all call. The system must be capable of operating all speakers at the same time. The microphone must be hand-held style. Hand-held microphones must be housed in a separate protective cabinet. The cabinet must be accessible without the use of a key. The location of the microphone(s) must be approved by the Designated Fire Protection Engineer (DFPE).
- b. The microprocessor must actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative must automatically cause the three-pulse temporal pattern to take over all functions assigned to the failed unit in the event an alarm is activated.

2.3.4.1 Outputs and Operational Modules

All outputs and operational modules must 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. During a Mass Notification event, the control unit must not generate nor cause any trouble alarms to be generated with the Fire Alarm system.

2.3.4.2 Mass Notification

- a. The system must have the capability of utilizing an LOC with redundant controls of the FMCU. Notification Appliance Circuits (NAC) must be provided for the activation of strobe appliances. Audio output must be selectable for line level. A hand-held microphone must be provided and, upon activation, must take priority over any tone signal, recorded message or PA microphone operation in progress, while

maintaining the strobe NAC circuit activation.

- b. The Mass Notification functions must override the manual or automatic fire alarm notification. Other fire alarm functions including transmission of a signal(s) to the fire department must remain operational. When a mass notification announcement is disengaged and a fire alarm condition still exists, the audible and visual notification appliances must resume activation for alarm conditions. The fire alarm message must be of lower priority than all other messages (except any "test" messages) and must not override any other messages.
- c. Messages must be recorded professionally utilizing standard industry methods, in a professional female voice. Message and tone volumes must both be at the same decibel level. Messages recorded from the system microphone must not be accepted. A 1000 Hz tone (as required by NFPA 72) must precede messages and be similar to the following unless Installation or Facility specific messages are required:
 - (1) Carbon Monoxide: "May I have your attention please. May I have your attention please. High levels of carbon monoxide have been detected in the building. Please leave the building by the nearest exit or exit stair." (Provide a 2second pause.) "May I have your attention please, (repeat the tones and message on a continuous loop)."
 - (2) Fire: "May I have your attention please. May I have your attention please. A fire has been reported in the building. Please leave the building by the nearest exit or exit stair." (Provide a 2second pause.) "May I have your attention please, (repeat the tones and message on a continuous loop)."
- d. Auxiliary Input Module must be designed to be an outboard expansion module to either expand the number of optional LOC's, or allow a telephone interface.

2.3.4.3 Installation-Wide Control

If an installation-wide control system for mass notification exists on the Base, the autonomous control unit must communicate with the central control unit of the Installation-wide system. The autonomous control unit must receive commands/messages from the central control unit and provide status information.

2.3.5 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 must not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.3.6 Field Programmability

Provide control units and control units that are fully field programmable for both input and output of control, initiation, notification, supervisory, and trouble functions. The system program configuration must be menu driven. System changes must be password protected. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system must be

provided as part of this contract.

A lockout code must not be installed in the hardware, firmware, or software of any fire protection system. The installer and operator codes must remain as the factory default setting.

2.3.7 Input/Output Modifications

The FMCU must contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features must consist of a control unit mounted keypad. Any bypass or modification to the system must indicate a trouble condition on the FMCU.

2.3.8 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.

2.3.9 Walk Test

The FMCU must have a walk test feature. When using this feature, operation of initiating devices must result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated in the history log, but no other outputs occur.

2.3.10 History Logging

The control unit must have the ability to store a minimum of 400 events in a log. These events must be stored in a battery-protected memory and must remain in the memory until the memory is downloaded or cleared manually. Resetting of the control unit must not clear the memory.

2.3.11 Manual Access

An operator at the control unit, having a proper access level, must have the capability to manually access the following information for each initiating device.

- a. Primary status.
- b. Device type.
- c. Present average value.
- d. Present sensitivity selected.
- e. Detector range (normal, dirty).

2.3.12 Floor Plans

A laminated building floor plan (22" x 34") must be provided and mounted at the FMCU location. The floor plan must indicate the FMCU, LOC, annunciators, remote power supply panel(s), and all initiating devices. The floor plan must indicate all rooms by number.

A laminated as-installed fire alarm wiring diagram (22" x 34") must be provided and mounted at the FMCU location. The wiring diagram must indicate fire alarm wiring, FMCU, LOC, annunciators, remote power supply

panel(s), and all initiating device and notification appliances keyed to floor plans by room number. Provide a different color for each signaling line circuit, notification appliance circuit, speaker circuit, and data circuits.

2.4 LOCAL OPERATING CONSOLES (LOC)

2.4.1 General

The LOC must consist of a remote microphone station incorporating a push-to-talk (PTT) hand-held microphone and system status indicators. The LOC must have the capability of being utilized to activate prerecorded messages. The unit must incorporate microphone override of any tone generation or recorded messages. The unit must be fully supervised from the FMCU. The housing for the LOC must not be lockable.

2.5 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 must be housed in a remote FMCU, terminal cabinet, or in the FMCU. Individual amplifiers must be 100 watts maximum.

2.5.1 Operation

The system must automatically operate and control all building speakers.

2.5.2 Construction

Amplifiers must utilize computer grade solid state components and must 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.

2.5.3 Inputs

Equip each system with separate inputs for the tone generator, digitalized voice driver and control unit mounted microphone. Microphone inputs must be of the low impedance, balanced line type. Both microphone and tone generator input must be operational on any amplifier.

2.5.4 Tone Generator

The tone generator must produce a three-pulse temporal pattern and must be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator must 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. The tone generator must be provided with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces.

2.5.5 Protection Circuits

Each amplifier must be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any

component must cause illumination of a visual "amplifier trouble" indicator on the control unit, appropriate logging of the condition in the history log, and other actions for trouble conditions as specified.

2.6 REMOTE ANNUNCIATOR

2.6.1 LCD Annunciator

Provide a flush mounted annunciator that includes an LCD display. The display must indicate the device in trouble/alarm or any supervisory device. Display the device name, address, and actual building location. The remote annunciator must duplicate functions of the FMCU for message display, fire alarm, supervisory alarm, and trouble conditions, visual and audible notification, and system reset functions. Remote annunciator must require the use of a key for accessing the reset, control and other functions.

A building floor plan must be provided and mounted (behind Plexiglass or similar protective material) at the annunciator location. The floor plan must indicate all rooms by name and number including the locations of stairs and elevators. The floor plan must show all devices and their programmed address to facilitate identification of their physical location from the LCD display information.

2.7 MANUAL STATIONS

Provide metal or plastic, surface mounted, double-action, addressable manual stations, that are not subject to operation by jarring or vibration.

Stations must be addressable via a dual in-line package (DIP) switch or sundial that is manufactured within the device. Stations must 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 must be finished in red with molded raised lettering operating instructions of contrasting color. The use of a key must be required to reset the station.

2.8 SMOKE DETECTORS

2.8.1 Spot Type Detectors

Provide addressable photoelectric smoke detectors as follows:

- a. Provide analog/addressable photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with **UL 268** Smoke detectors must be listed for use with the FMCU.
- b. Provide self-restoring type detectors that do not require any readjustment after actuation at the FMCU to restore them to normal operation. The detector must have a visual indicator to show actuation.
- c. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.
- d. Provide twist lock bases with screw terminals for each conductor. The detectors must maintain contact with their bases without the use of springs.

- e. The detector address must identify the particular unit, its location within the system, and its sensitivity setting. Detectors must be of the low voltage type rated for use on a 24 VDC system.

2.8.2 Duct Smoke Detectors

Duct-mounted addressable photoelectric smoke detectors must consist of a smoke detector, as specified in paragraph Spot Type Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry must be mounted in a metallic or plastic enclosure exterior to the duct. It is not permitted to cut the duct insulation to install the duct detector directly on the duct. Detectors must be listed for operation over the complete range of air velocities, temperature and humidity expected at the detector when the air-handling system is operating. Detectors must be powered from the FMCU.

- a. Sampling tubes must run the full width of the duct. The duct detector package must conform to the requirements of NFPA 90A, UL 268A, and must be listed for use in air-handling systems. The control functions, operation, reset, and bypass must be controlled from the FMCU.
- b. Lights to indicate the operation and alarm condition must be visible and accessible with the unit installed and the cover in place. Remote indicators must be provided where required by NFPA 72. Remote indicators as well as the affected fan units must be properly identified in etched plastic placards.
- c. Detectors must provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 23.13 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC. Auxiliary contacts provide for this function must be located within 3 feet of the controlled circuit or appliance. The auxiliary contacts must be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

2.9 CARBON MONOXIDE DETECTOR

Analog/addressable carbon monoxide (CO) detectors must be listed to UL 2075 and set to respond to the sensitivity limits of UL 2034. Carbon monoxide detectors must be listed for use with fire alarm control units. Detectors must be surface mounted in the vertical or horizontal orientation and supported independently of wiring connections. Detectors must be self-restoring. For FMCU with no listed compatible addressable CO detectors, provide listed 4-wire detectors. Do not provide CO detectors with local alarms. Detector must be provided with an LED status indicator.

- a. Where 4-wire CO detectors are necessary, each 4-wire CO detector must be individually monitored via addressable interface modules for alarm and off normal/trouble conditions (including loss of power to the individual detector). Power circuits for 4-wire CO detectors must be dedicated to powering the CO detectors only. Battery powered and 120 VAC powered detectors are prohibited.
- b. Wiring connections must be made by means of screw terminals and detectors must be equipped with trouble relays. Detectors must be able to mount a single-gang electrical box.

- c. A trouble condition at an individual CO detector must not affect any other CO detectors. CO detectors must be powered by the FMCU.
- d. Detectors must be provided with a means to test CO gas entry into the CO sensing cell.

2.10 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored must be configured as a Class "B" initiating device circuits. The module must be listed as compatible with the control unit. The module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. Monitor module must 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. Modules must be listed for the environmental conditions in which they will be installed.

2.11 ADDRESSABLE CONTROL MODULES

The control module must be capable of operating as a relay (dry contact form C) for interfacing the control unit with other systems, and to control door holders or initiate elevator fire service. The module must be listed as compatible with the control unit. The indicating device or the external load being controlled must be configured as Class "B" notification appliance circuits. The system must be capable of supervising, audible, visual and dry contact circuits. The control module must have both an input and output address. The supervision must detect a short on the supervised circuit and must prevent power from being applied to the circuit. The control module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module must contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules must be listed for the environmental conditions in which they will be installed.

2.12 NOTIFICATION APPLIANCES

2.12.1 Audible Notification Appliances

Audible appliances must conform to the applicable requirements of [UL 464](#). Appliances must be connected into notification appliance circuits. Surface mounted audible appliances must be painted white. Recessed audible appliances must be installed with a grill that is painted white.

2.12.1.1 Speakers

- a. Speakers must conform to the applicable requirements of [UL 1480](#). Speakers must 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. Interior speaker tap settings must include taps of 1/4, 1/2, 1, and 2 watt, at a minimum. Exterior speakers must also be multi-tapped with no more than 15 watt maximum setting. Speakers must incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 400 Hz to 4,000 Hz, and must have a sealed back construction. Speakers must 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 must be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FMCU.

- b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 16 gage or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes must be ground and finished to provide a smooth and neat appearance for each plate. Each plate must be primed and painted.
- c. Speakers must utilize screw terminals for termination of all field wiring.

2.12.2 Visual Notification Appliances

Visual notification appliances must conform to the applicable requirements of UL 1638, UL 1971 and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED) and be marked "Alert" in letters of contrasting color. The light pattern must be dispersed 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 must be 1 flash per second and a minimum of 15 candela based on the UL 1971 test. Strobe must be semi-flush mounted.

2.13 ELECTRIC POWER

2.13.1 Primary Power

Power must be 120 VAC 60 Hz service for the FMCU 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 must be automatic and must not cause transmission of a false alarm.

2.14.1 Batteries

Provide sealed, maintenance-free, sealed lead acid batteries as the source for emergency power to the FMCU. Batteries must contain suspended electrolyte. The battery system must 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 must be the greater of the following two capacities. This capacity applies to every control unit associated with this system, including supplemental notification appliance circuit panels, auxiliary power supply panels, fire alarm transmitters, and Base-wide mass notification transceivers. When determining the required capacity under alarm condition, visual notification appliances must include both textual and non-textual type appliances.

- a. 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.
- b. Sufficient capacity to operate the mass notification for 60 minutes after loss of AC power.

2.14.1.2 Battery Power Calculations

- a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.
 - (1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each system component and each control unit component, and compliance with [UL 864](#).
 - (2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.
 - (3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components. Calculations must be performed using the minimum rated voltage of each component.
- b. For battery calculations 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. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits 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 must be capable of providing 120 percent of the connected system load and must maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must 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 SURGE PROTECTIVE DEVICES

[Surge protective devices](#) must be provided to suppress all voltage transients which might damage fire alarm control unit components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on any signaling line circuit. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the FMCU breaker is located.

- a. Surge protective devices for nominal 120 VAC must be [UL 1449](#) listed

with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must also meet [IEEE C62.41.1](#) and [IEEE C62.41.2](#) category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. Any unit fusing must be externally accessible.

- b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be [UL 497B](#) listed, meet [IEEE C62.41.1](#) and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for fire [alarm wiring](#). The base assembly must accept "plug-in" surge protective module.
- c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:
 - (1) For 120 VAC nominal line voltage: [UL 1449](#) and [UL 1283](#) listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.
 - (2) For 24-volt nominal line voltage: [UL 497B](#) listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.
 - (3) For alarm telephone dialers: [UL 497A](#) listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.
 - (4) For IP-DACTS: [UL 497B](#) listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

2.16 WIRING

Provide wiring materials under this section as specified in Section [26 20 00](#) INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.

2.16.1 Alarm Wiring

IDC and SLC wiring must be solid [or stranded](#) copper cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring must be No. 14AWG size conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 14 AWG size conductors at a minimum. Speaker circuits must be copper No. 16 AWG size twisted and shielded conductors at a minimum. Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors and/or appliances. Power wiring, operating at 120 VAC minimum, must 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 must comply with [NFPA 70](#).

2.17 INTERFACE TO THE BASE-WIDE MASS NOTIFICATION NETWORK

2.17.1 Radio

Furnish a SIRCOM ISU-118, VHF (Indoor Speaker Unit) mass notification transceiver and additional equipment as noted on sheet FA503 of the contract drawings. The transceiver will be installed by the government.

2.17.2 Secure Radio System

2.17.2.1 Communications Network

The communications network provides two-way signals between central control units and autonomous control units (in individual building systems), and should include redundant (primary and backup) communication links. The system must incorporate technology to prevent easy interruption of the radio traffic for MNS alerting.

2.17.2.2 Radio Frequency Communications

Use of radio frequency-type communications systems must comply with National Telecommunications and Information Administration (NTIA) requirements. The systems must be designed to minimize the potential for interference, jamming, eavesdropping, and spoofing.

2.17.2.3 Licensed Radio Frequency Systems

An approved DD Form 1494 for the system is required prior to operation.

2.18 AUTOMATIC FIRE ALARM TRANSMITTERS

2.18.1 Digital Alarm Communicator Transmitter (DACT)

Provide DACT that is compatible with the existing supervising station fire alarm system. Transmitter must have a means to transmit alarm, supervisory, and trouble conditions via a single transmitter. Transmitter must have a source of power for operation that conforms to NFPA 72. Transmitter must be capable of initiating a test signal daily at any selected time. Transmitter must be arranged to seize telephone circuits in accordance with NFPA 72. Transmitter must be compatible with the Sur-Gard System III Multi-Platform Digital Telephone Receiver.

2.18.2 Signals to Be Transmitted to the Base Receiving Station

Points must be sent to the base receiving station utilizing Contact ID Protocol.

2.19 SYSTEM MONITORING

2.19.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, sprinkler service entrance valve, isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, must be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address.

2.20 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures must be provided to permit fire alarm/mass notification components to be used in areas that exceed the environmental limits of the listing. The enclosure must be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the component is currently listed. Guards required to deter mechanical damage must be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

3.2.1 Fire Alarm and Mass Notification Control Unit (FMCU)

Locate the FMCU where indicated on the drawings. Surface mount 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 must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the FMCU. Locate the document storage cabinet adjacent to the FMCU unless the Contracting Officer directs otherwise.

3.2.2 Battery Cabinets

When batteries will not fit in the FMCU, locate battery cabinets below or adjacent to the FMCU. Battery cabinets must be installed at an accessible location when standing at floor level. Battery cabinets must not be installed lower than **12 inches** above finished floor, measured to the bottom of the cabinet, nor higher than **36 inches** above the floor, measured to the top of the cabinet. Installing batteries above drop ceilings or in inaccessible locations is prohibited. Battery cabinets must be large enough to accommodate batteries and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions. The cabinet must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must indicate the control unit(s) the batteries power and must not be less than **1-inch** high.

3.2.3 Manual Stations

Locate manual stations as required by **NFPA 72** and as indicated on the drawings. Mount stations so they are located no farther than **5 feet** from the exit door they serve, measured horizontally. Manual stations must be mounted at **48 inches** measured to the operating handle.

3.2.4 Notification Appliances

- a. Locate notification appliance devices as required by NFPA 72, where indicated, and to meet the intelligibility requirements. Where two or more visual notification appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring. Audible and visual notification appliances mounted in acoustical ceiling tiles must be centered in the tiles plus or minus 2 inches.
- b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.
- c. Speakers must not be located in close proximity to the FMCU or LOC so as to cause feedback when the microphone is in use.

3.2.5 Smoke Detectors

Locate detectors as required by NFPA 72 and their listing and as indicated on the drawings on a 4-inch mounting box. Smoke detectors are permitted to be on the wall no lower than 12 inches from the ceiling with no minimum distance from the ceiling. Install smoke detectors no closer than 3 feet from air handling supply diffusers. Detectors installed in acoustical ceiling tiles must be centered in the tiles plus or minus 2 inches.

3.2.6 Carbon Monoxide Detectors

Locate detectors as required by NFPA 72 and their listings and as indicated on the drawings on a 4-inch mounting box. Carbon monoxide detectors must be installed separate from smoke and/or heat detectors.

3.2.7 LCD REMOTE Annunciator

Locate the LCD annunciator as shown on the drawings. Mount the annunciator, with the top 6 feet above the finished floor or center the annunciator at 5 feet, whichever is lower.

3.2.8 Local Operating Console (LOC)

Locate the LOC(s) as required by NFPA 72 and as indicated. Mount the console so that the top message button and microphone is no higher than 4 feet above the floor and the bottom (lowest) message button and microphone is at least 3 feet above the finished floor.

3.2.9 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.3 SYSTEM FIELD WIRING

3.3.1 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 must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts, crimped connectors, or similar devices is prohibited. The twisting of conductors is prohibited. Wiring to conform with 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 must show connections from field devices to the FMCU and remote fire alarm/mass notification 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.

3.3.2 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 must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "FIRE ALARM TERMINAL CABINET" with 2-inch lettering, on the front of the terminal cabinet.

3.3.3 Alarm Wiring

- a. Voltages must not be mixed in any conduit or junction box, housing or device, except those containing power supplies and control relays.
- b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the FMCU.
- c. Pigtail or T-tap connections to signal line circuits, initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited.
- d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.
- e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the Designated Fire Protection Engineer (DFPE).

3.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

- a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.
- b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage or outdoors. Use die-cast compression connectors.
- c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.
- d. Flexible metal conduit is permitted for initiating device circuits 6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use liquid tight flexible metal conduit in damp and wet locations.
- e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.
- f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

3.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, FMCU and the LOC must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FMCU, and remote FMCU must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12 point lettering minimum size, and mounted within each cabinet, control unit, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.4 CONNECTION OF NEW SYSTEM

The following new system connections must be made during the last phase of construction, at the beginning of the pre-Government tests. New system connections must include:

- a. Connection of new system transmitter to existing installation fire reporting system.

Once these connections are made, system must be left energized. Report

immediately to the Contracting Officer, coordination and field problems resulting from the connection of the above components.

3.5 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.

3.6 PAINTING

- a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.
- b. In finished areas, paint exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands 3/4-inch wide at 10-foot centers and at each side of a floor, wall, or ceiling penetration.
- c. Painting must comply with Section 09 90 00 PAINTS AND COATINGS.

3.7 FIELD QUALITY CONTROL

3.7.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level IV Fire Alarm Technician, and the representative of the installing company, and reviewed by the QFPE 60 days prior to performing system tests. Detailed test procedures must 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, annunciators, special hazard equipment, emergency communication equipment, interface equipment, and surge protective devices. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 72 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government testing. The test data forms must record the test results and must:

- a. Identify the NFPA Class of all Initiating Device Circuits (IDC), and 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 these tests must 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 smoke detector testing. The use of magnets is not permitted.
- 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.

3.7.2 Pre-Government Testing

3.7.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that devices and circuits are functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" as required by NFPA 72. The contractor and an authorized representative from each supplier of equipment must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 72 including all referenced annex sections and the test reports noted below.

- a. NFPA 72 Record of Completion.
- b. NFPA 72 Record of Inspection and Testing.
- c. Fire Alarm and Emergency Communication System Inspection and Testing Form.
- d. Audibility test results with marked-up test floor plans.
- e. Intelligibility test results with marked-up floor plans.
- f. Documentation that all tests identified in the paragraph "Minimum System Tests" are complete.

3.7.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the Designated Fire Protection Engineer (DFPE). Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation-wide fire reporting system and the installation-wide mass notification system have been completed and tested to confirm communications are fully functional. Submit request for test at least 15 calendar days prior to the requested test date.

3.7.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.7.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

- a. The manufacturer's technical representative.
- b. The contractor's Qualified Fire Protection Engineer (QFPE).
- c. Marked-up red line drawings of the system as actually installed.
- d. Loop resistance test results.
- e. Complete program printout including input/output addresses.
- f. Copy of pre-Government Test Certificate, test procedures and completed test data forms.
- g. Audibility test results with marked-up floor plans.
- h. Intelligibility test results with marked-up floor plans.

Government Final Tests will be witnessed by the Designated Fire Protection Engineer, and Qualified Fire Protection Engineer (QFPE). At this time, any and all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.8 MINIMUM SYSTEM TESTS

3.8.1 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

- a. 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 must be witnessed by the Contracting Officer and test results recorded for use at the final Government test.
- b. Verify the absence of unwanted voltages between circuit conductors and ground. Wiring must be free of opens, shorts, and grounds. The tests must be accomplished at the pre-Government test with results available at the final system test.
- c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.
- d. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

- e. Carbon Monoxide Detector Tests: Carbon monoxide detectors must be tested in accordance with NFPA 72 and the manufacturer's recommended calibrated test method.
- 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 FMCU. Hard copy records of the software must 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 detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must 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.
- q. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.8.2 Audibility Tests

Sound pressure levels from audible notification appliances must be a minimum of 15 dBa over ambient with a maximum of 110 dBa in any occupiable area. The provisions for audible notification (audibility and intelligibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

3.8.3 Intelligibility Tests

Intelligibility testing of the System must be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, and ASA S3.2. 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 0.7. Rounding of values is permitted.
- 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 DFPE, 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, sleeping, as appropriate).
- f. The distance the occupant must walk to the location meeting the minimum required CIS value must 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 NFPA 72 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

3.9 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the Final Government Test.

- a. The drawings must be prepared electronically and sized no less than the contract drawings. Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of AutoCAD, DXF and portable document formats 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.
- d. Provide [Operation and Maintenance \(O&M\) Instructions](#).

3.10 [INSTRUCTION OF GOVERNMENT EMPLOYEES](#)

3.10.1 Instructor

Provide the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the operation, inspection, testing, and maintenance of the system provided. The instructor must train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm system. The instructor must be thoroughly familiar with all parts of this installation. The instructor must be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the training history.

3.10.2 Required Instruction Time

Provide 8 hours of instruction after final acceptance of the system. The instruction must be given during regular working hours on such dates and times selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training must allow for rescheduling for unforeseen maintenance and/or fire department responses.

3.10.2.1 Technical Training

Equipment manufacturer or a factory representative must provide 1 day of on site and 5 days of technical training to the Government at the manufacturing facility [for 5 government personnel](#). Training must allow for classroom instruction as well as individual hands on programming, troubleshooting and diagnostics exercises. Factory training must occur within 6 months of system acceptance.

3.10.3 Technical Training Manual

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training must familiarize designated government personnel with proper operation of the installed system. The maintenance training course must provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

3.11 EXTRA MATERIALS

3.11.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is

responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturers. Installing fire alarm contractor is NOT responsible for any damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.11.2 Spare Parts

Install a spare parts box adjacent to the FMCU. Spare parts box must be a steel cabinet with locking, hinge-mounted door. Spare parts box must be mounted no more than 3-ft above the finished floor.

Spare parts furnished must be directly interchangeable with the corresponding components of the installed systems. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be placed in the spare parts box and must be accompanied by an inventory list.

3.11.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

- a. As-built shop drawings
- b. Product data sheets
- c. Design calculations
- d. Site-specific software data package
- e. All documentation required by SD-06.

-- End of Section --

SECTION 31 11 00

CLEARING AND GRUBBING

11/18

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Tree Wound Paint

SD-04 Samples

Tree Wood Paint

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

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 ADMINISTRATIVE REQUIREMENTS and Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS 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.

3.2.1 Tree Removal

Where indicated or directed, remove trees and stumps that are designated as trees 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, pruning or grubbing such as limbs, tree tops, roots, stumps, logs, rotten wood, and other similiar materials is the property of the Contractor and dispose 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
is the property of the Contractor and dispose of as specified.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 31 23 00.00 20

EXCAVATION AND FILL
02/11, CHG 2: 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 in the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600 (2017) Installation of Ductile-Iron Mains and Their Appurtenances

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M (2018) Standard Specification for Concrete Aggregates

ASTM C136/C136M (2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM D698 (2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

ASTM D1140 (2017) Standard Test Methods for Determining the Amount of Material Finer than 75- μ m (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 D2216 (2019) Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

ASTM D2321 (2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

ASTM D2487 (2017; E 2020) 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)

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2014) Safety -- Safety and Health Requirements Manual

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SW-846.3-3 (1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

1.2 DEFINITIONS

1.2.1 Capillary Water Barrier

A layer of clean, poorly graded crushed rock, stone, or natural sand or gravel having a high porosity which is 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 a slab.

1.2.2 Degree of Compaction

Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D1557, for general soil types, abbreviated as percent laboratory maximum density.

1.2.3 Hard Materials

Weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.2.4 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.

1.2.5 Pile Supported Structure

As used herein, a structure where both the foundation and floor slab are pile supported.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shoring and Sheeting Plan

Dewatering work plan

Submit 15 days prior to starting work.

SD-06 Test Reports

Borrow Site Testing; G

Fill and backfill test

Select material test; G

Porous fill test for capillary water barrier; G

Density tests; G

Moisture Content Tests

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

1.4 DELIVERY, STORAGE, AND HANDLING

Perform in a manner to prevent contamination or segregation of materials.

1.5 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. Hard materials and rock will not be encountered.
- d. Borrow material in the quantities required is not available on Government property.
- e. Blasting will not be permitted. Remove material in an approved manner.

1.6 REQUIREMENTS FOR OFF SITE SOIL

Soils brought in from off site for use as backfill shall be tested for petroleum hydrocarbons, BTEX, PCBs and HW characteristics (including toxicity, ignitability, corrosivity, and reactivity). Backfill shall not contain concentrations of these analytes above the appropriate State and/or EPA criteria, and shall pass the tests for HW characteristics.

Determine petroleum hydrocarbon concentrations by using appropriate State protocols. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5035/8260B. Perform complete TCLP in accordance with EPA SW-846.3-3 Method 1311. Perform HW characteristic tests for ignitability, corrosivity, and reactivity in accordance with accepted standard methods. Perform PCB testing in accordance with accepted standard methods for sampling and analysis of bulk solid samples. Provide borrow site testing for petroleum hydrocarbons and BTEX from a grab sample of material from the area most likely to be contaminated at the borrow site (as indicated by visual or olfactory evidence), with at least one test from each borrow site. For each borrow site, provide borrow site testing for HW characteristics from a composite sample of material, collected in accordance with standard soil sampling techniques. Do not bring material onsite until tests results have been received and approved by the Contracting Officer.

1.7 QUALITY ASSURANCE

1.7.1 Shoring and Sheet Piling Plan

Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheet piling of excavations. Drawings shall include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations shall include data and references used.

The Contractor is required to hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer shall be responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer shall update the excavation, sheet piling and dewatering plans as construction progresses to reflect changing conditions and shall submit an updated plan if necessary. A written report shall be submitted, at least monthly, 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 Geotechnical Engineer shall be available to meet with the Contracting Officer at any time throughout the contract duration.

1.7.2 Dewatering Work Plan

Submit procedures for accomplishing dewatering work.

1.7.3 Utilities

Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Perform work adjacent to non-Government utilities as indicated in accordance with procedures outlined by utility company. Excavation made with power-driven equipment is not permitted within two 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.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

2.1.1 Common Fill

Approved, unclassified soil material with the characteristics required to compact to the soil density specified for the intended location.

2.1.2 Backfill and Fill Material

ASTM D2487, classification GW, GP, GM, SW, SP, SM, with a maximum ASTM D4318 liquid limit of 35, maximum ASTM D4318 plasticity index of 12, and a maximum of 25 percent by weight passing ASTM D1140, No. 200 sieve.

2.1.3 Select Material

Provide materials classified as GW, GP, SW, or SP, by ASTM D2487 where indicated. The liquid limit of such material shall not exceed 35 percent when tested in accordance with ASTM D4318. The plasticity index shall not be greater than 12 percent when tested in accordance with ASTM D4318, and not more than 35 percent by weight shall be finer than No. 200 sieve when tested in accordance with ASTM D1140.

2.1.4 Topsoil

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.

2.2 POROUS FILL FOR CAPILLARY WATER BARRIER

ASTM C33/C33M fine aggregate grading with a maximum of 3 percent by weight passing ASTM D1140, No. 200 sieve, or coarse aggregate Size 57, 67, or 77 and conforming to the general soil material requirements specified in paragraph entitled "Satisfactory Materials."

2.3 UTILITY BEDDING MATERIAL

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. Backfill to top of pipe shall be compacted to 95 percent of ASTM D698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide ASTM D2321 materials as follows:

- a. Class I: Angular, 0.25 to 1.5 inches, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

2.4 BORROW

Obtain borrow materials required in excess of those furnished from excavations from sources outside of Government property, at Contractor's expense.

2.5 BURIED WARNING AND IDENTIFICATION TAPE

Polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch 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. Color and printing shall be permanent, unaffected by moisture or soil.

Warning Tape Color Codes	
Red:	Electric
Yellow:	Gas, Oil; Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Potable Water Systems
Green:	Sewer Systems
White:	Steam Systems
Gray:	Compressed Air
Purple:	Non Potable, Reclaimed Water, Irrigation and Slurry lines

2.5.1 Detectable Warning Tape for Non-Metallic Piping

Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.6 DETECTION WIRE FOR NON-METALLIC PIPING

Detection wire shall be insulated single strand, solid copper with a minimum of 12 AWG.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Shoring and Sheeting

Provide shoring bracing, cribbing, trench boxes, underpinning and sheeting where indicated or required. In addition to Section 25 A and B of EM 385-1-1 include provisions in the shoring and sheeting plan that will accomplish the following:

- a. Prevent undermining of pavements, foundations and slabs.

- b. Prevent slippage or movement in banks or slopes adjacent to the excavation.
- c. Allow for the abandonment of shoring and sheeting materials in place in critical areas as the work is completed. In these areas, backfill the excavation to within 3 feet of the finished grade and remove the remaining exposed portion of the shoring before completing the backfill.

3.1.2 Drainage and Dewatering

Provide for the collection and disposal of surface and subsurface water encountered during construction.

3.1.2.1 Drainage

So that construction operations progress successfully, completely drain construction site during periods of construction to keep soil materials sufficiently dry. The Contractor shall establish/construct storm drainage features 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/or provide temporary ditches, dikes, swales, and other drainage features and equipment as required to maintain dry soils, prevent erosion and undermining of foundations. 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. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

3.1.2.2 Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted 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. Control measures shall be taken 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, the water level shall be maintained continuously, at least 2 feet below the working level.

3.1.3 Underground Utilities

Location of the existing utilities indicated is approximate. The Contractor shall physically verify the location and elevation of the existing utilities indicated prior to starting construction. The Contractor shall scan the construction site with electromagnetic and sonic equipment and mark the surface of the ground where existing underground utilities are discovered.

3.1.4 Machinery and Equipment

Movement of construction machinery and equipment over pipes during construction shall be at the Contractor's risk. Repair, or remove and provide new pipe for existing or newly installed pipe that has been displaced or damaged.

3.2 SURFACE PREPARATION

3.2.1 Clearing and Grubbing

Unless indicated otherwise, remove trees, stumps, logs, shrubs, brush and vegetation and other items that would interfere with construction operations within the clearing limits. Remove stumps entirely. Grub out matted roots and roots over 2 inches in diameter to at least 18 inches below existing surface.

3.2.2 Stripping

Strip suitable soil from the site where excavation or grading is indicated and stockpile separately from other excavated material. Material unsuitable for use as topsoil shall be wasted. Locate topsoil so that the material can be used readily for the finished grading. Where sufficient existing topsoil conforming to the material requirements is not available on site, provide borrow materials suitable for use as topsoil. Protect topsoil and keep in segregated piles until needed.

3.2.3 Unsuitable Material

Remove vegetation, debris, decayed vegetable matter, sod, mulch, and rubbish in excavations.

3.3 EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Reuse excavated materials that meet the specified requirements for the material type required at the intended location. Keep excavations free from water. Excavate soil disturbed or weakened by Contractor's operations, soils softened or made unsuitable for subsequent construction due to exposure to weather. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be removed as directed. Refill with select material and compact to 95 percent of ASTM D698 maximum density. Unless specified otherwise, refill excavations cut below indicated depth with select material and compact to 95 percent of ASTM D698 maximum density. Satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer, shall be replaced with satisfactory materials to the indicated excavation grade; except as specified for spread footings. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Contracting Officer.

3.3.1 Structures With Spread Footings

Ensure that footing subgrades have been inspected and approved by the Contracting Officer prior to concrete placement. Fill over excavations with concrete during foundation placement.

3.3.2 Pipe Trenches

Excavate to the dimension indicated. Grade bottom of trenches to provide uniform support for each section of pipe after pipe bedding placement. Tamp if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe.

3.3.3 Excavated Materials

Satisfactory excavated material suitable for fill or backfill shall be placed in the proper section of the permanent work required or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified in Paragraph "DISPOSITION OF SURPLUS MATERIAL."

3.4 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Contracting Officer. The surface shall be scarified to a depth of 6 inches before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified for the adjacent fill. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Minimum subgrade density shall be as specified herein.

3.4.1 Proof Rolling

Proof rolling shall be done 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 15 ton, pneumatic-tired roller. Operate the 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 miles per hour. Notify the Contracting Officer a minimum of 3 days prior to proof rolling. Proof rolling shall be performed in the presence of the Contracting Officer. Rutting or pumping of material shall be undercut as directed by the Contracting Officer.

3.5 FILLING AND BACKFILLING

Fill and backfill to contours, elevations, and dimensions indicated. Compact each lift before placing overlaying lift.

3.5.1 Common Fill Placement

Provide for general site. Use satisfactory materials. Place in 6 inch lifts. Compact areas not accessible to rollers or compactors with mechanical hand tampers. Aerate material excessively moistened by rain to a satisfactory moisture content. Finish to a smooth surface by blading, rolling with a smooth roller, or both.

3.5.2 Select Material Placement

Provide under porous fill of structures not pile supported. Place in 6 inch lifts. Do not place over wet or frozen areas.

3.5.3 Backfill and Fill Material Placement Over Pipes and at Walls

Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and 1 foot above other utility lines shall be free from stones larger than 1 inch in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall.

3.5.4 Porous Fill Placement

Provide under floor and area-way slabs on a compacted subgrade. Place in 4 inch lifts with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.5.5 Trench Backfilling

Backfill as rapidly as construction, testing, and acceptance of work permits. Place and compact backfill under structures and paved areas in 6 inch lifts to top of trench and in 6 inch lifts to one foot over pipe outside structures and paved areas.

3.6 BORROW

Where satisfactory materials are not available in sufficient quantity from required excavations, approved borrow materials shall be obtained as specified herein.

3.7 BURIED WARNING AND IDENTIFICATION TAPE

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.8 BURIED DETECTION WIRE

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

3.9 COMPACTION

Determine in-place density of existing subgrade; if required density exists, no compaction of existing subgrade will be required. Density requirements specified herein are for cohesionless materials. When cohesive materials are encountered or used, density requirements may be reduced by 5 percent.

3.9.1 General Site

Compact underneath areas designated for vegetation and areas outside the 5 foot line of the paved area or structure to 85 percent of ASTM D698.

3.9.2 Structures, Spread Footings, and Concrete Slabs

Compact top 12 inches of subgrades to 95 percent of ASTM D698. Compact select material to 95 percent of ASTM D698.

3.9.3 Adjacent Area

Compact areas within 5 feet of structures to 95 percent of ASTM D698.

3.9.4 Paved Areas

Compact top 12 inches of subgrades to 95 percent of ASTM D1557. Compact fill and backfill materials to 95 percent of ASTM D1557.

3.10 FINISH OPERATIONS

3.10.1 Grading

Finish grades as indicated within one-tenth of one foot. Grade areas to drain water away from structures. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

3.10.2 Topsoil and Seed

Scarify existing subgrade. Provide 4 inches of topsoil for newly graded finish earth surfaces and areas disturbed by the Contractor. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to seeding, planting, or proper grading. If there is insufficient on-site topsoil meeting specified requirements for topsoil, provide topsoil required in excess of that available.

Provide mulch and water to establish an acceptable stand of grass.

3.10.3 Protection of Surfaces

Protect newly backfilled, graded, and topsoiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.11 DISPOSITION OF SURPLUS MATERIAL

Remove from Government property.

3.12 FIELD QUALITY CONTROL

3.12.1 Sampling

Take the number and size of samples required to perform the following tests.

3.12.2 Testing

Perform one of each of the following tests for each material used. Provide additional tests for each source change.

3.12.2.1 Fill and Backfill Material Testing

Test fill and backfill material in accordance with ASTM C136/C136M for conformance to ASTM D2487 gradation limits; ASTM D1140 for material finer than the No. 200 sieve; ASTM D4318 for liquid limit and for plastic limit; ASTM D698 or ASTM D1557 for moisture density relations, as applicable.

3.12.2.2 Select Material Testing

Test select material in accordance with ASTM C136/C136M for conformance to ASTM D2487 gradation limits; ASTM D1140 for material finer than the No. 200 sieve; ASTM D698 or ASTM D1557 for moisture density relations, as applicable.

3.12.2.3 Porous Fill Testing

Test porous fill in accordance with ASTM C136/C136M for conformance to gradation specified in ASTM C33/C33M.

3.12.2.4 Density Tests

Test density in accordance with ASTM D1556/D1556M, or ASTM D6938. When ASTM D6938 density tests are used, verify density test results by performing an ASTM D1556/D1556M density test at a location already ASTM D6938 tested as specified herein. Perform an ASTM D1556/D1556M density test at the start of the job, and for every 10 ASTM D6938 density tests thereafter. Test each lift at randomly selected locations every 2000 square feet of existing grade in fills for structures and concrete slabs and pavements, and every 2500 square feet for other fill areas and every 2000 square feet of subgrade in cut. Include density test results in daily report.

Bedding and backfill in trenches: One test per 50 linear feet in each lift.

3.12.2.5 Moisture Content Tests

In the stockpile, excavation or borrow areas, a minimum of two tests per day per type of material or source of materials being placed is required during stable weather conditions. During unstable weather, tests shall be made as dictated by local conditions and approved moisture content shall be tested in accordance with ASTM D2216. Include moisture content test results in daily report.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 31 31 16.13

CHEMICAL TERMITE CONTROL
08/22

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. DEPARTMENT OF DEFENSE (DOD)

DODI 4150.07

(2019) DOD Pest Management Program

1.2 ADMINISTRATIVE REQUIREMENTS

Coordinate work related to final grades, landscape plantings, foundations, or any other alterations to the finished construction which might alter the condition of treated soils.

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 Contractor Quality Control approval 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

Termiticide Application Plan; G

SD-03 Product Data

Termiticides

SD-05 Design Data

Mixing Formulation

SD-06 Test Reports

Soil Moisture

Calibration Test

SD-07 Certificates

Qualifications; G

Foundation Exterior

Utilities and Vents

Crawl and Plenum Air Spaces

List of Equipment

SD-08 Manufacturer's Instructions

Termiticides

SD-11 Closeout Submittals

Verification of Measurement

Warranty

Pest Management Report

1.4 QUALITY CONTROL

1.4.1 Regulatory Requirements

Comply with **DODI 4150.07** for requirements on Contractor's licensing, certification, and record keeping. Maintain daily records using the Pest Management Maintenance Record, DD Form 1532-1, or a computer generated equivalent, and submit copies of records when requested by the Contracting Officer. These forms may be obtained from the main web site:

https://www.esd.whs.mil/Directives/forms/fmo_poc/

1.4.2 Qualifications

For the application of pesticides, use the services of an applicator whose principal business is pest control. The applicator must be commercially certified in the state where the work is to be performed as required by **DODI 4150.07**. No contractor personnel may work under the supervision of a certified person even where this is permitted practice in those States or host nations in which the DOD property is located. Termiticide applicators must also be certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control. Submit a copy of the pest control business license and pesticide applicator certificates to the Contracting Officer prior to any applications.

1.4.3 Safety Requirements

Formulate, apply, and dispose of termiticides and their containers in accordance with label directions. Draw water for formulating only from sites designated by the Contracting Officer, and fit the filling hose with a backflow preventer meeting local plumbing codes or standards. Maintain an air gap between the filling hose and tank. Perform filling operations under the direct and continuous observation of a contractor's representative to prevent overflow. Secure pesticides and related materials under lock and key when unattended. Ensure that proper protective clothing and equipment are worn and used during all phases of termiticide application. Dispose of used pesticide containers off Government property.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver termiticide material to the site in the original unopened containers bearing legible labels indicating the EPA registration number, manufacturer's registered uses and in new or otherwise good condition as supplied by the manufacturer or formulator.

1.5.2 Inspection

Inspect termiticides upon arrival at the job site for conformity to type and quality in accordance with paragraph TERMITICIDES. Each label must bear evidence of registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended or under appropriate regulations of the host county. Inspect other materials for conformance with specified requirements. Remove unacceptable materials from the job site.

1.5.3 Storage

Storage of pesticides on the installation will not be permitted unless it is written into the contract.

1.5.4 Handling

Handle and mix termiticides in accordance with the manufacturer's label and SDS, preventing contamination by dirt, water, and organic material. Protect termiticides from weather elements as recommended by the manufacturer's label and SDS. Spill kits must be maintained on pest control vehicles and must be available at the mixing site. Conduct termiticide mixing in an area that has been approved by the Integrated Pest Management Coordinator (IPMC) or Contracting Officer, and with adequate spill containment that can contain at least 110 percent of the volume of the tank.

1.6 SITE CONDITIONS

The following site conditions determine the acceptable time of application.

1.6.1 Soil Moisture

Test soils to be treated immediately before application. Test soil moisture content to a minimum depth of 3 inches. The soil moisture must be as recommended by the termiticide manufacturer. Application of the termiticide is not permitted when soil moisture content exceeds manufacturer's recommendations.

1.6.2 Runoff and Wind Drift

Application of termiticide will not be permitted during or immediately following heavy rains, when conditions may allow runoff, when it may create an environmental hazard or when average wind speed exceeds 10 miles per hour. Termiticide is not permitted to enter water systems, aquifers, or endanger humans or animals.

1.7 WARRANTY

Provide a 5 year written warranty against infestations or reinfestations by subterranean termites of the buildings or building additions

constructed under this contract. Include in the warranty annual inspections of the buildings or building additions during the warranty period. If live subterranean termite infestation or subterranean termite damage is discovered during the warranty period, and the soil and building conditions have not been altered in the interim:

- a. Re-treat the site and perform other treatment as may be necessary for elimination of subterranean termite infestation;
- b. Repair damage caused by termite infestation; and
- c. Reinspect the building approximately 180 days after the re-treatment.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Chemical termite control uses liquid termiticide treatments applied to the soil to form a continuous chemical barrier in the soil around both sides of the foundation. The application can be surface applied or rodded and trenched. This barrier prevents foraging termites from reaching the foundation and piers. Only the soil adjacent to these foundation elements is treated. For slab construction (including foundations, patios and garages), the entire soil (or gravel) surface is treated before the vapor barrier is installed and the slab poured over it. Soil treatment is coordinated with all building activities from foundation construction through final grading of the soil around the building's exterior. In order for the treatment to be effective, the final phase of the application must be done after final grading and sometimes after landscaping is completed so that the treated soil is not disturbed.

2.2 MATERIALS

2.2.1 Termiticides

Provide termiticides currently registered by the EPA or approved for such use by the appropriate agency of the host county and as approved by the Contracting Officer. Select non-repellent termiticides (active ingredient: chlorantraniliprole, chlorfenapyr, fipronil, or imidacloprid) for maximum effectiveness and duration after application. Select a termiticide that is suitable for the soil and climatic conditions at the project site and apply at the highest labeled rate. Submit manufacturer's label and Safety Data Sheet (SDS) for termiticides proposed for use.

PART 3 EXECUTION

3.1 PREPARATION

Before termiticide application begins, remove all cellulose containing materials from the site such as wood debris from clearing and grubbing and post construction wood scraps, such as ground stakes, form boards, cardboard paper, and scrap lumber from the site.

3.1.1 Verification

Before work starts, verify that final grades are as indicated and smooth grading has been completed in accordance with Section 31 23 00.00 20 E XCAVATION AND FILL. Finely grade soil and remove particles larger than 1 inch. Compact soil particles to eliminate soil movement.

3.1.2 Foundation Exterior

If the exterior perimeter treatment is applied before major construction is completed it will be damaged or removed. The exterior foundation perimeter treatment will have to occur in phases during completion of any pads, porches, aprons, sidewalks, final grading, or landscape plantings adjacent to the building foundation. These treatment areas should be coordinated after all major construction but before any pads, porches, or other items requiring special consideration are poured adjacent to the foundation walls. Submit written verification that final grading, landscape planting, and other items adjacent to the foundation will not disturb treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures.

3.1.3 Utilities and Vents

Turn off and block HVAC ducts and vents located in the treatment area prior to application to protect people and animals from termiticide. Submit written verification that the HVAC ducts and vents, water and sewer lines, and plumbing have been turned off or blocked prior to applying termiticide.

3.1.4 Crawl and Plenum Air Spaces

Submit written verification that crawl and plenum air spaces have been located and identified prior to applying termiticide.

3.1.5 Application Plan

Prior to commencing application of termiticide, submit a [Termiticide Application Plan](#) addressing the following items:

- a. proposed sequence of treatment work including dates and times of application
- b. termiticide trade name
- c. EPA registration number
- d. chemical composition
- e. concentration of original and diluted material
- f. formulation
- g. manufacturer's recommended application rates
- h. regional requirements
- i. application rate of active ingredients
- j. method of application
- k. area or volume to be treated
- l. amount to be applied
- m. copy of the pest control business license

- n. copy of the pesticide applicator certificates

3.2 APPLICATION

For areas to be treated, establish complete and unbroken vertical and horizontal soil chemical barriers between the soil and all portions of the intended structure which may allow termite access to wood and wood related products. Make applications to crawl spaces in accordance with label directions. Applications to crawl space areas that are used as plenum air spaces will not be permitted.

3.2.1 Equipment Calibration and Tank Measurement

Submit a [list of equipment](#) to be used. Conduct [calibration test](#) on the application equipment to be used immediately prior to commencement of termiticide application. Measure the volume and contents of the application tank. Testing must confirm that the application equipment is operating within the manufacturer's specifications and meets the specified requirements. Submit written certification of the equipment calibration test results within one week of testing. Where results from the equipment calibration and tank measurements tests are unsatisfactory, re-treatment will be required.

3.2.2 Mixing and Application

Perform all work related to formulating, mixing, and application in the presence of the Contracting Officer's representative, a DOD certified pesticide applicator, Pest Management Quality Assurance Evaluator (QAE)/Performance Assessment Representative (PAR), or IPMC. Applications must be made at the highest rate or concentration allowed by the label. Submit [mixing formulation](#):

- a. Quantity of pesticide used.
- b. Rate of dispersion.
- c. Percent of use.
- d. Total amount used.

A closed system is recommended as it prevents the termiticide from coming into contact with the applicator or other persons. Only use water from designated locations. Fit filling hoses with a backflow preventer meeting local plumbing codes or standards. Maintain an air gap between filling hoses and tanks. Prevent overflow during the filling operation. Spill kits must be maintained on pest control vehicles and must be available at the mixing site. Termiticide mixing must be conducted in an area that has been designated by the IPMC or Contracting Officer and that has adequate spill containment. Inspect the application equipment prior to each day of use for leaks, clogging, wear, or damage. Immediately perform repairs on the application equipment to prevent or eliminate leaks and clogging.

3.2.2.1 Application Method

3.2.2.1.1 Surface Application

Use surface applications for establishing horizontal barriers. Apply termiticide as a coarse spray and provide uniform distribution over the

soil surface. Termiticide must penetrate a minimum of 1 inch into the soil, or as recommended by the manufacturer. If soils are treated to a depth less than specified or approved, repeat work performed to the depth specified at no additional cost to the Government.

3.2.2.1.2 Rodding and Trenching

Use rodding and trenching for establishing vertical soil barriers. Trenching must be to the depth of the foundation footing. Width of trench must be as recommended by the manufacturer, or as indicated. Rodding or other approved method may be implemented for saturating the base of the trench with termiticide. Backfill the trench immediately after termiticide has reached maximum penetration as recommended by the manufacturer. If maximum penetration is not achieved, as recommended by the manufacturer, repeat work performed to maximum penetration as recommended by the manufacturer at no additional cost to the Government. Backfill in 6 inch rises or layers. Treat each rise or layer with termiticide.

3.2.3 Sampling

The Contracting Officer may draw samples for analysis, at any time and without prior notice, from stocks at the job site to determine if the amount of active ingredient specified on the label is being applied. When analysis, performed by the Government, indicates samples contain less than the amount of active ingredient specified on the label, repeat work performed with pesticides conforming to this specification at no additional cost to the Government.

3.2.4 Vapor Barriers and Waterproof Membranes

Apply termiticide prior to placement of a vapor barrier or waterproof membrane.

3.2.5 Placement of Concrete

Place concrete covering treated soils after the termiticide has reached maximum penetration into the soil as recommended by the manufacturer. Cover treated areas with plastic if slab is not to be poured immediately following termiticide application.

3.2.6 Clean Up, Disposal, and Protection

Once application has been completed, proceed with clean up and protection of the site without delay.

3.2.6.1 Clean Up

Clean the site of all material associated with the treatment according to label instructions, and as indicated. Remove and dispose of excess and waste material off Government property.

3.2.6.2 Disposal of Termiticide

Dispose of residual termiticides and containers off Government property, and in accordance with label instructions and EPA criteria.

3.3 FIELD QUALITY CONTROL

3.3.1 [Verification of Measurement](#)

Once termiticide application has been completed, measure tank contents to determine the remaining volume. The total volume measurement of used contents for the application must equal the application rate established in the application plan. Submit written verification that the volume of termiticide used meets the application rate established in the application plan.

3.3.2 Inspection

3.3.2.1 Technical Representative

Provide a technical representative who is a DOD certified pesticide applicator, Pest Management QAE/PAR, or IPMC. The technical representative must be present at all meetings concerning treatment measures for subterranean termites and during treatment application. Contact the Integrated Pest Management Coordinator prior to starting work.

3.4 CLOSEOUT ACTIVITIES

Upon completion of this work, submit the [Pest Management Report](#) DD Form 1532, or an equivalent computer product, to the Integrated Pest Management Coordinator. This form identifies the target pest, type of operation, brand name and manufacturer of pesticide, formulation, concentration or rate of application used.

3.5 PROTECTION

3.5.1 Protection of Treated Area

Immediately after the application, protect the area from other use by erecting barricades as required or directed. Place signage inside the entrances to crawl spaces and identify the space as treated with termiticide and not safe for children or animals.

3.5.2 Disturbance of Treated Soils

Re-treat soil and fill material disturbed after treatment before placement of slabs or other covering structures.

-- End of Section --

SECTION 32 11 23

AGGREGATE BASE COURSE

05/22

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 C29/C29M	(2017a) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling 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/ft ³) (2700 kN-m/m ³)
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D3665	(2012; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4718/D4718M	(2015) Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles

ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured 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 D7928	(2017) Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
ASTM E11	(2022) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NCDOT)

NCDOT	(2018) Standard Specifications for Roads and Structures
-------	---

1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Aggregate Base Course

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 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, 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 laboratory maximum dry density in accordance with ASTM D1557 Method C and corrected with ASTM D4718/D4718M.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools; G

ABC Stone; G

Waybills and Delivery Tickets

SD-06 Test Reports

Initial Tests; G

In-Place Tests; G

Sampling and Testing

Field Density

1.4 QUALITY ASSURANCE

Perform sampling and testing using a laboratory approved in accordance with Section 01 45 00.00 20 QUALITY CONTROL. Do not start work requiring testing 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. Furnish copies of test results within 24 hours of completion of the tests.

1.4.1 Sampling

Take samples for laboratory testing in conformance with ASTM D75/D75M. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.4.2 Tests

Perform the following tests in conformance with the applicable standards listed:

1.4.2.1 Gradation Analysis

Perform gradation 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 ASTM D7928.

1.4.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D4318.

1.4.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture content in accordance with paragraph DEGREE OF COMPACTION.

1.4.2.4 Field Density Tests

Measure field density in accordance with ASTM D1556/D1556M, 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 Annex A2 of ASTM D6938. Use ASTM D6938 to determine the moisture content of the soil. 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 Annex A2 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.

- a. Submit certified copies of test results for approval not less than 30 days before material is required for the work.
- b. Submit calibration curves and related test results prior to using the device or equipment being calibrated.
- c. Submit copies of field test results within 24 hours after the tests are performed.

1.4.2.5 Wear Test

Perform wear tests on ABC course material in conformance with [ASTM C131/C131M](#).

1.4.2.6 Flat and Elongated Pieces

Determine flat and elongated pieces on ABC course material in conformance with [ASTM D4791](#), Method A.

1.4.2.7 Fractured Faces

Perform fractured faces test on ABC coarse aggregate in conformance with [ASTM D5821](#).

1.4.2.8 Weight of Slag

Determine weight per cubic foot of slag in accordance with [ASTM C29/C29M](#) on the ABC course material.

1.5 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.

1.6 ACCEPTANCE

1.6.1 Tolerances

Acceptance of ABC is based on compliance with the tolerances presented in Table 1. Remove any materials found to be non-compliant and replace with compliant material or rework, as directed, to meet the requirements of this specification

TABLE 1	
Measurement	Tolerance

TABLE 1	
Grade	Plus 1/4 inch, Minus 1/2 inch
Smoothness	Plus/Minus 3/8 inch
Individual Test Total Thickness	Plus/Minus
Average Job Thickness	Plus/Minus
Compaction	Minimum 100 percent

PART 2 PRODUCTS

2.1 AGGREGATES

Provide ABC conforming to NCDOT, Section 1005.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Initial Tests

Perform one of each of the following initial 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. Gradation Analysis.
- b. Liquid limit and plasticity index.
- c. Moisture-density relationship.
- d. Wear.
- e. Flat and Elongated Pieces.
- f. Fractured Faces.
- g. Weight per cubic foot of Slag.

2.2.2 Approval of Material

Select the source of the material 30 days prior to the time the material will be required in the work. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted courses.

2.3 EQUIPMENT, TOOLS, AND MACHINES

All plant, equipment, and tools used in the performance of the work are subject to approval by the Government 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.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the ABC is constructed in more than one lift, clean the previously constructed lift of loose and foreign matter by sweeping with power sweepers or power brooms. Use hand brooms in areas where power cleaning is not practicable. 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 or authorities. Clear, strip, and excavate as required. 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 to prevent segregation. Stockpile materials obtained from different sources separately.

3.4 PREPARATION OF UNDERLYING COURSE

Clean the underlying course or subgrade of all foreign substances prior to constructing the base course(s). Do not construct base course(s) 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 recompact 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 base course(s). Stabilize by mixing ABC into the underlying course and compacting by approved methods. Proof roll in accordance with paragraph PROOF ROLLING. 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 compliant condition until the base course is placed.

3.5 GRADE CONTROL

Provide a finished and completed 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

3.6.1 Mixing

Mix the coarse and fine aggregates in a stationary plant, or in a traveling plant. Make adjustments in mixing procedures or in equipment to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to produce a satisfactory base course meeting all requirements of this specification.

3.6.2 Placing

Place the mixed material on the prepared subgrade or subbase in lifts of uniform thickness with an approved spreader. Place the lifts so that when compacted they are true to the grades or levels required with the least possible surface disturbance. Where the base course is placed in more than one lift, clean the previously constructed lift of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to produce an acceptable base course.

3.7 LAYER THICKNESS

Compact the completed base course to the thickness indicated. Limit individual compacted lifts to a maximum thickness of 6 inches and a minimum thickness of 3 inches. Compact the base course(s) to a total thickness that is within the tolerances of paragraph ACCEPTANCE 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 recompact 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. However, the requirements for wearing course thickness and plan grade are still applicable. The average job thickness will be the average of all thickness measurements taken for the job and within the tolerances of paragraph ACCEPTANCE of the thickness indicated.

3.8 COMPACTION

Compact each lift of the base course, as specified, with approved compaction equipment. For cohesive soils, maintain water content during the compaction procedure to within plus or minus 2 percent of the optimum water content determined from laboratory tests as specified and for cohesionless soils, maintain the water content to facilitate compaction without bulking. 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 until each lift is compacted through the full depth to meet the compaction requirements of Table 1. Make such adjustments in compacting or finishing procedures to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to produce a compliant base course. Remove any materials found to be non-compliant and replace with compliant material or rework, as directed, to meet the requirements of this specification.

3.9 PROOF ROLLING

In addition to the compaction specified, proof roll areas designated on the drawings by application of **two** coverages of a heavy pneumatic-tired roller having four or more tires abreast, each tire loaded to a minimum of **30,000 pounds** and inflated to a minimum of **125 psi**. A coverage is defined as the application of one tire print over the designated area. In the areas designated, apply proof rolling to the top of the underlying material on which the base course is laid and to the top of each **layer** of base course. Maintain water content of the underlying material and each lift of the base course as specified in Paragraph COMPACTION from start of compaction to completion of proof rolling of that lift. Remove any base course materials or any underlying materials that produce permanent deformation exceeding **3/8 inch** by proof rolling and replace with satisfactory materials. Then recompact and proof roll to meet these specifications.

3.10 EDGES OF BASE COURSE

Place the base course(s) so that the completed section is a minimum of **one-half foot** wider, on all sides, than the next lift that will be placed above it. Place approved material along the outer edges of the 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 lifts, simultaneously roll and compact at least a **2 foot** width of this shoulder material with the rolling and compacting of each lift of the base course.

3.11 FINISHING

Finish the surface of the top lift of base course after final compaction and proof rolling by cutting any overbuild to grade and rolling with a steel-wheeled roller. Do not add thin lifts of material to the top lift of base course to meet grade. If the elevation of the top lift of base course exceeds the tolerances of paragraph ACCEPTANCE, scarify the top lift to a depth of at least **3 inches** and blend new material in and compact **ed** and proof rolled to bring to grade. Make adjustments to rolling and finishing procedures to minimize segregation and degradation, obtain grades, maintain moisture content, and produce an acceptable base course. If the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, scarify the non-compliant portion and rework and recompact it or replace as directed.

3.12 SMOOTHNESS TEST

Construct the top lift so that the surface shows no deviations exceeding the tolerances of paragraph ACCEPTANCE when tested with a **12 foot** straightedge. Test the entire area in both a longitudinal and a transverse direction on parallel lines. Perform the transverse lines at a maximum spacing of **15 feet** or less apart, as directed. Perform the longitudinal lines at the centerline of each placement lane, regardless of whether multiple lanes are allowed to be paved at the same time, and at the 1/8th point in from each side of the lane. Hold the straightedge in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and measuring the maximum gap between the straightedge and the pavement surface. Determine measurements along the entire length of the straight edge. 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.

3.13 FIELD QUALITY CONTROL

3.13.1 In-Place Tests

Perform each of the following **in-place tests** on samples taken from the placed and compacted ABC. Determine sample locations using random sampling in accordance with **ASTM D3665**. 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. Gradations containing more than 30 percent retained on the **¾ inch** sieve can produce inconsistent compacted density values when tested in accordance with paragraph DEGREE OF COMPACTION.
- b. Perform gradation 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 base 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 base course.

3.13.2 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).

3.14 TRAFFIC

Do not allow traffic on the completed base course.

3.15 MAINTENANCE

Maintain the base 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 base 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 of base course that is damaged as necessary to comply with this specification.

3.16 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 11 26

HOT-MIX BITUMINOUS BASE COURSE FOR ROADS AND STREETS
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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 156 (2013; R 2017) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

ASPHALT INSTITUTE (AI)

AI MS-2 (2015) Asphalt Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C183/C183M (2015) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement

ASTM D75/D75M (2019) Standard Practice for Sampling Aggregates

ASTM D140/D140M (2016) Standard Practice for Sampling Asphalt Materials

ASTM D1856 (2009; R 2015) Recovery of Asphalt from Solution by Abson Method

ASTM D2041/D2041M (2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

ASTM D2172/D2172M (2017; E 2018) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures

ASTM D2726/D2726M (2019) Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures

ASTM D3665 (2012; R 2017) Standard Practice for Random Sampling of Construction Materials

ASTM D3666 (2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NCDOT)

NCDOT (2018) Standard Specifications for Roads
and Structures

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sources of Aggregates; G

Job Mix Formula; G

SD-06 Test Reports

Sources of Aggregates

Bituminous Materials; G

Test Section

Service Record

SD-09 Manufacturer's Field Reports

Batch Tickets

1.3 QUALITY CONTROL

1.3.1 Qualifications

Perform sampling and testing using an approved commercial testing laboratory or on-site facilities. Submit accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM D3666, including all applicable test procedures. Do not start work requiring testing until the facilities have been inspected and approved. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. Maintain this certification for the duration of the project.

1.3.2 Test Results

Verify that materials comply with the specification. When a material source is changed, test the new material for compliance. When deficiencies are found, repeat the initial analysis and retest the material already placed to determine the extent of unacceptable material. Replace or repair all in-place unacceptable material to conform to the contract requirements. Submit copies of field tests results within 24 hours after the tests are performed and certified copies of tests results for approval not less than 30 days before material is required for the work.

1.3.3 Batch Tickets

Provide [batch tickets](#) in accordance with [AASHTO M 156](#).

1.3.4 Aggregates

Select [sources of aggregates](#) and submit a plan for operation of a new source of aggregates at least 45 days in advance of starting production. If a previously developed source is selected, submit test results with evidence that central plant hot-mix bituminous pavements constructed with the aggregates have had a satisfactory [service record](#) of at least 5 years under similar climatic conditions. Include in the service record a tabulation of aggregate gradation and quality test results, typical hot-mix asphalt mix design using the aggregate, and a list of representative paving projects using the aggregate. Make such tests and other investigations as necessary to determine whether or not aggregates meeting the requirements specified can be produced from the proposed sources. Sample aggregates in accordance with [ASTM D75/D75M](#) and test them at the start of production.

1.3.5 Mineral Filler

Sample mineral filler in accordance with [ASTM C183/C183M](#).

1.3.6 Bituminous Materials

Select sources where [bituminous materials](#) are obtained in advance of time when materials will be required in the work. Sample bituminous materials in accordance with [ASTM D140/D140M](#). Submit test results not less than 30 days before such material is required for use in the work.

1.4 ENVIRONMENTAL REQUIREMENTS

Do not construct bituminous courses when the underlying course contains free surface water, or when temperature of the surface of the underlying course is below [40 degrees F](#), unless otherwise directed.

1.5 ACCEPTANCE

1.5.1 Tolerances

Acceptance of bituminous base course is based on compliance with the tolerances presented in Table 1. Remove and replace bituminous base course represented by the failing tests or submit repair plan for approval.

TABLE 1	
Attribute	Measurement
Plant Mixture	
Delivery to Laydown Machine	Minimum 250 deg F
Laboratory Air Voids	3 to 5 percent
Finished Mat	

TABLE 1	
Mat Density (avg of 4 cores/lot)	Minimum 92 percent of TMD
Joint Density (avg of 4 cores/lot)	Minimum 90.5 percent of TMD
Grade	plus/minus 0.05 foot
Smoothness	plus/minus 3/8 inch
Longitudinal Joint Offset	Minimum 1 foot
Transverse Joint Offset	Minimum

PART 2 PRODUCTS

2.1 AGGREGATES

Provide aggregates consisting of crushed stone, crushed slag, crushed gravel screenings, sand, and mineral filler, as required. Provide in accordance with NCDOT, Section 1012.

2.2 BITUMINOUS MATERIALS

2.2.1 Asphalt Cement

Provide asphalt cement binder conforming to NCDOT, Section 1020.

2.3 COMPOSITION OF MIXTURE

2.3.1 Job-Mix Formula (JMF)

2.3.1.1 Develop the JMF

Provide an asphalt mix composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt binder. Size the aggregate fractions, handle in separate size groups, and combine in such proportions that the resulting mixture meets the grading requirements of Table 2. Submit proposed JMF; do not produce hot-mix asphalt for payment until a JMF has been approved.

2.3.1.1.1 Binder Course

NCDOT, materials for the construction of the binder course shall be Type I-19.0C.

2.3.1.1.2 Surface Course

NCDOT, materials for construction of the surface course shall be Type RS-9.5C.

2.3.2 JMF Requirements

Submit in writing the job mix formula for approval at least 30 days prior to the start of the test section including as a minimum:

- a. Percent passing each sieve size.

- b. Percent of asphalt binder.
- c. Percent of each aggregate and mineral filler to be used.
- d. Asphalt performance grade.
- e. Number of blows of hand-held hammer per side of molded specimen. (NA for Superpave)
- f. Number of gyrations of Superpave gyratory compactor, (NA for Marshall mix design)
- g. Laboratory mixing temperature.
- h. Lab compaction temperature.
- i. Temperature-viscosity relationship of the asphalt cement.
- j. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.
- k. Graphical plots of stability (NA for Superpave), flow (NA for Superpave), air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in [AI MS-2](#).
- l. Specific gravity and absorption of each aggregate.
- m. Percent natural sand.
- n. Percent particles with 2 or more fractured faces (in coarse aggregate).
- o. Fine aggregate angularity.
- p. Percent flat or elongated particles (in coarse aggregate).
- q. Tensile Strength Ratio(TSR).
- r. Antistrip agent (if required) and amount.
- s. List of all modifiers and amount.
- t. Correlation of hand-held hammer with mechanical hammer (NA for Superpave).
- u. Percentage and properties (asphalt content, binder properties, and aggregate properties) of reclaimed asphalt pavement (RAP) in accordance with paragraph RECYCLED HOT-MIX ASPHALT, if RAP is used.

2.3.2.1 Adjustment to JMF

The JMF for each mixture is in effect until a new formula is approved in writing. Should a change in sources of any materials be made, perform a new mix design and obtain approval before the new material is used. Make minor adjustments within the specification limits to the JMF to optimize mix volumetric properties. Adjustments to the original JMF are limited to plus or minus 4 percent on the [No. 4](#) and coarser sieves; plus or minus 3 percent on the [No. 8](#) to [No. 50](#) sieves; and plus or minus 1 percent on the [No. 100](#) sieve. Adjustments to the JMF are limited to plus or minus 1.0

percent on the No. 200 sieve. Asphalt content adjustments are limited to plus or minus 0.40 from the original JMF. If adjustments are needed that exceed these limits, develop a new mix design.

2.4 EQUIPMENT, TOOLS, AND MACHINES

2.4.1 Bituminous Plant

Provide a bituminous plant of such capacity to produce the quantities of bituminous mixtures required for the project within the completion time of the contract. Provide hauling equipment, paving machines, rollers, miscellaneous equipment, and tools in sufficient numbers and capacity and in proper working condition to place the bituminous paving mixtures at a rate equal to the plant output. Provide a sufficient number of adequately trained personnel during paving operations to produce a pavement meeting the requirements in this specification.

2.4.2 Mixing Plants

Provide mixing plants in accordance with AASHTO M 156 which are automatic or semiautomatic controlled, commercially manufactured units designed, coordinated, and operated to consistently produce a mixture within the job-mix formula (JMF). Prequalify drum or batch mixers at the production rate to be used during actual mix production. The prequalification tests include extraction in accordance with ASTM D2172/D2172M and recovery of the asphalt binder in accordance with ASTM D1856.

2.4.3 Asphalt Paver

Provide asphalt pavers which are self-propelled, with an activated screed, heated as necessary, and capable of spreading and finishing courses of hot-mix asphalt which will meet the specified thickness, smoothness, and grade, with sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. Provide a receiving hopper of sufficient capacity to permit a uniform spreading operation and equipped with a distribution system to place the mixture uniformly in front of the screed without segregation and produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. If screed extensions are used to increase the paving width, provide auger extensions to distribute the hot mix along the additional screed length. Equip the paver with a control system capable of automatically maintaining the specified screed elevation. Automatically actuate the control system from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface.

2.4.4 Hauling Equipment

Provide trucks for hauling hot-mix asphalt having tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, lightly coat the truck beds with a release agent specifically designed for use with hot mix asphalt. Provide each truck with a suitable cover to protect the mixture from adverse weather. When necessary to maintain the mixture at the specified temperature, insulate or heat truck beds and securely fasten covers (tarps).

2.4.5 Rollers

Provide the number, type, and weight of rollers sufficient to compact the mixture to the required density while it is still in a workable condition. Do not use equipment which causes excessive crushing of the aggregate or displacement of the asphalt mixture.

2.4.6 Straightedge

Furnish and maintain at the site, in good condition, one 12 foot straightedge for each bituminous paver for use in testing the finished surface. Construct straightedges of aluminum with blades of box or box-girder cross section and a flat bottom reinforced to insure rigidity and accuracy. Provide handles to facilitate movement on pavement.

PART 3 EXECUTION

3.1 CONDITIONING OF UNDERLYING COURSE

Prior to placing the bituminous base course, clean the underlying surface of foreign or objectionable matter.

3.2 TRANSPORTATION OF BITUMINOUS MIXTURE

Transport the bituminous mixture from the paving plant to the site in trucks having tight, clean, smooth beds lightly coated with an approved release agent to prevent adhesion of mixture to truck bodies. Drain excessive release agent prior to loading. Cover each load with canvas or other approved material of ample size to protect mixture from weather and prevent loss of heat. Reject loads that have crusts of cold, unworkable material or have become wet by rain. Do not haul over freshly placed material.

3.3 PLACING

Do not place bituminous mixtures without ample time to complete placement and compaction during daylight hours, unless artificial lighting is provided.

3.3.1 Offsetting Joints in Bituminous Base Course

Place the bituminous base course so that longitudinal joints are offset from joints in the underlying course by at least 1 foot. Offset transverse joints by at least 2 feet from transverse joints in the underlying course.

3.3.2 Use of Laydown Machine

Reject mixtures having temperatures less than 250 degrees F when delivered to the laydown machine. Adjust the laydown machine and regulate the speed so that the surface of the course being laid will be smooth and continuous without tears and pulls, and of such depth that, when compacted, the surface conforms to the cross section, grade, and contour indicated. Begin placement of the mixture along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture as nearly continuous as possible, and adjust the speed of placing to permit proper compaction. When segregation occurs in the mixture during placing, suspend the laydown operation until the cause is determined and corrected. Correct irregularities in alignment of the course left by the

laydown machine by trimming directly behind machine. Immediately after trimming, thoroughly compact the edges of the course by tamping laterally with a lute. Do not permit distortion of the course during tamping.

3.3.3 Placing Strips Succeeding Initial Strips

In placing each succeeding strip after the initial strip has been spread and compacted as specified below, overlap the screed of the laydown machine 1/2 to 1 inch over the previously placed strip and sufficiently high so that compaction will produce a smooth, dense joint. Use a lute to push back the mixture placed on the edge of the previously placed strip to the edge of the strip being placed. Do not broadcast material onto the mat. Remove and waste excess mixture.

3.3.4 Hand Spreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, spread the mixture by hand. Prevent segregation during spreading. Do not broadcast material onto the mat. Remove and waste excess mixture. Maintain grade and smoothness tolerances presented in Table 1.

3.4 COMPACTION OF MIXTURE

Begin compaction as soon after placing as the mixture will bear roller without undue displacement. Do not permit delays in compacting the freshly placed mixture. After the initial rolling, perform preliminary tests of the crown, grade, and smoothness. Correct deficiencies so that the finished course will conform to requirements for the grade and smoothness specified in subpart: ACCEPTANCE. After meeting crown, grade, and smoothness requirements, continue rolling until a mat density of at least 92 percent of the theoretical maximum density (TMD) determined in accordance with ASTM D2041/D2041M is obtained. Roll the joints until until a joint density of at least 90.5 percent of the theoretical maximum density (TMD) determined in accordance with ASTM D2041/D2041M is obtained. Thoroughly compact areas inaccessible to rollers with hot hand tampers.

3.4.1 Correcting Deficient Areas

Remove mixtures that become contaminated or are defective. Do not permit skin patching of an area that has been rolled. Cut holes the full thickness of the base course so that the sides are perpendicular and parallel to the direction of traffic and the edges are vertical. Spray sides with tack. Place hot mix asphalt in the holes in sufficient quantity so that the finished surface will conform to grade, smoothness, and density requirements.

3.5 JOINTS

3.5.1 General

Carefully construct joints between old and new pavements or between successive day's work or joints that have become cold to establish a continuous bond between old and new sections of the course. Construct joints having the same texture, density, and smoothness as other sections of the course. Clean contact surfaces of previously constructed pavements that have become coated with dust, sand, or other objectionable material by brushing or cut back with approved power saw, as approved. Spray the surface against which new material is placed with a thin, uniform coat of

tack coat. Apply the material far enough in advance of placement of the fresh mixture to insure adequate curing. Take care to prevent damage or contamination of sprayed surface.

3.5.2 Transverse Joints

Pass the roller over the unprotected end of freshly placed mixture only when placing of the course is discontinued or when delivery of the mixture is interrupted to the extent that the unrolled material may become cold. In all cases, cut back the edge of the previously placed course a minimum of 2 inches to expose an even, straight, vertical surface for the full thickness of the course. In continuing placement of the strip, position the mechanical spreader on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling that conforms to the required density and smoothness specified herein.

3.5.3 Longitudinal Joints

Cut back edges of a previously placed strip that have cooled or are irregular, honeycombed, poorly compacted, damaged, or otherwise defective. In all cases, cut back the edge of the previously placed course a minimum of 2 inches to expose an even, straight, vertical surface for the full thickness of the course.

3.6 EDGES OF PAVEMENT

Neatly trim outside edges adjacent to shoulders.

3.7 QUALITY CONTROL

Perform tests in sufficient numbers and at the locations and times directed to ensure that materials, mixtures and compaction meet specified requirements. Obtain samples of finished pavement, including samples that span the longitudinal joint. Sample bituminous materials during construction when shipments of bituminous materials are received or when necessary to assure that some condition of handling or storage has not been detrimental to the bituminous material.

3.7.1 Sampling

Obtain plant mix and in-place samples on a lot and subplot basis. Each full day's production or a maximum of 1000 tons is considered a lot. Divide the lot into four (4) equal sublots and obtain random samples in accordance with ASTM D3665 within each subplot. Obtain plant mix samples from the haul truck or from behind the paver. Test for grade and smoothness on a total lot basis.

3.7.2 In-Place Density

Take one random core (4 inches or larger in diameter) from the mat (interior of the lane) of each subplot, and one random core from the joint (immediately over joint) of each subplot, with each random core the full thickness of the layer being placed. When the random core is less than 1 inch thick, do not include in the analysis. In this case, take another random core. After air drying to a constant weight, determine the density of each core in accordance with ASTM D2726/D2726M. Determine percent compaction using the TMD. Evaluate for acceptance in accordance with subpart: ACCEPTANCE. Remove and replace unacceptable lots.

3.7.3 Laboratory Air Voids and Theoretical Maximum Density

Calculate laboratory air voids by determining the bulk density of each lab compacted specimen using the laboratory-prepared, thoroughly dry method of [ASTM D2726/D2726M](#) and determining the theoretical maximum density of each subplot sample using [ASTM D2041/D2041M](#). Use the latest theoretical maximum density value to calculate the laboratory air voids for each subplot. Evaluate for acceptance in accordance with subpart: ACCEPTANCE. Complete and report all laboratory air void tests within 24 hours after completion of construction of each lot.

3.7.4 Plan Grade

Provide finished surfaces conforming, within tolerances specified, to the lines, grades, and cross sections indicated. Do not permit finished surfaces to vary more than the tolerances provided in subpart: ACCEPTANCE from the plan gradeline and elevation established and approved at the site. Maintain finished surfaces flush with finished surfaces of abutting pavements. Do not permit deviations from the plan gradeline and elevation in areas of pavements where closer conformance with plan grade and elevation is required for the proper functioning of drainage and other appurtenant structures involved.

3.7.5 Surface Smoothness

Provide finished surfaces not deviating from the testing edge of a straightedge more than the tolerances of subpart: ACCEPTANCE in any direction.

3.7.6 Temperatures

Check temperatures at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.8 PROTECTION OF PAVEMENT

After final rolling of the pavement, do not permit vehicular traffic of any kind until the pavement has cooled to ambient temperature.

-- End of Section --

SECTION 32 17 23

PAVEMENT MARKINGS
08/16, CHG 5: 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 in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D6628 (2003; R 2015) Standard Specification for
Color of Pavement Marking Materials

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI 03732 (1997) Selecting and Specifying Concrete
Surface Preparation for Sealers, Coatings,
and Polymer Overlays

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A (2017) Colors used in Government
Procurement

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD (2009; Rev 2012) Manual on Uniform Traffic
Control Devices

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-P-1952 (2015; Rev F; Notice 1) Paint, Traffic and
Airfield Markings, Waterborne

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Surface Preparation Equipment List; G

Application Equipment List; G

Exterior Surface Preparation

Safety Data Sheets; G

Waterborne Paint; G

SD-06 Test Reports

Waterborne Paint; G

SD-07 Certificates

Qualifications; G

Waterborne Paint

Volatile Organic Compound, (VOC); G

SD-08 Manufacturer's Instructions

Waterborne Paint; G

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 Shotblasting Equipment

Use mobile self propelled shotblasting equipment capable of producing an adjustable depth of paint removal and of propelling abrasive particles at high velocities on the paint for effective removal. Ensure each unit is self cleaning and self contained. Use equipment able to confine the abrasive, any dust that is produced, and removed paint and is capable of recycling the abrasive for reuse.

2.1.1.1.4 Grinding or Scarifying Equipment

Use equipment capable of removing surface contaminants, paint build-up, or extraneous markings from the pavement surface without leaving any residue. Clean the surface by hydro blast to remove surface contaminants and ash after a weed torch is used to remove paint.

2.1.1.1.5 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.

2.2 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 and [SAE AMS-STD-595A](#) for airfields. Provide materials conforming to the requirements specified herein.

2.2.1 Waterborne Paint

[FS TT-P-1952](#), Type I or II.

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.

3.2 EXTERIOR SURFACE PREPARATION

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, existing paint markings, 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.

- b. Scrub affected areas, where oil or grease is present on old pavements to be marked, with several applications of trisodium phosphate solution or other approved detergent or degreaser and rinse thoroughly after each application. After cleaning oil-soaked areas, seal with shellac or primer recommended by the manufacturer to prevent bleeding through the new paint. Do not commence painting in any area until pavement surfaces are dry and clean.

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.

3.3.2 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 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.

3.4.2 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.

3.4.3 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.

-- End of Section --

RR1 Repair by Replacement
MCB Camp Lejeune, NC

Project# P1594
27 April 2023

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 31 13.53

HIGH-SECURITY FENCES (ORNAMENTAL) AND GATES
11/21

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.

ASTM INTERNATIONAL (ASTM)

ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C94/C94M	(2022a) Standard Specification for Ready-Mixed Concrete
ASTM F567	(2014a; R 2019) Standard Practice for Installation of Chain Link Fence
ASTM F2408	(2016) Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets
ASTM F2814	(2009; R 2015) Standard Guide for Design and Construction of Ornamental Steel Picket Fence Systems for Security Purposes

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fence Installation Drawings; G

SD-03 Product Data

Posts; G

Sleeves; G

Latches; G

Hinges; G

Stops; G

Keepers; G

Ornamental Fence Systems; G

Swing Gates; G

SD-07 Certificates

Gate Hardware and Accessories; G

Concrete

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials elevated off of the ground to protect against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 COMPONENTS

2.1.1 Ornamental Fence Systems

Submit manufacturer's catalog data. Provide **ASTM F2814** structural components consisting of tubular steel ornamental pickets and rails. Provide **ASTM F2408** industrial class pickets with a minimum cross-sectional area of **1 sq in** and a minimum wall thickness of **14 gauge**. Provide pickets with spear-pointed tips extending a minimum of **6 in** above the top rail of the fence. Mount pickets to a top and bottom rail spaced a maximum of **80 inches** apart. Space pickets along rails with a maximum gap not to exceed **2.25 inches**. Secure pickets to rails by welding. Provide all items and accessories finished by PVC powder-coating in black.

2.1.2 Ornamental Fence Gates

2.1.2.1 Swing Gates

Submit manufacturer's catalog data. Fabricate swing gates by welding **2 sq in** tubular steel ends and rails. Use pickets that match the adjacent fence construction. Reinforce gates to ensure assembly sags no more than 1% of the gate leaf width or **2 in**, whichever is less. Size gate **posts** to accommodate the weight and width of each gate leaf. Mount gates to posts with weldable steel plates or blocks, pressed steel, or malleable iron **hinges**. Hot-dip galvanize all hinges with a minimum zinc weight of **1.20 oz/sq ft**. Provide hinge with stainless steel pin. Secure all tamper points by welding or peening the threads. Use swing gate latches and drop bar guides manufactured of pressed steel, hot-dipped galvanized with a minimum zinc weight of **1.20 oz/sq ft**. Finish all gate hardware in the same color/coating as the fence system.

2.2 MATERIALS

2.2.1 Concrete

ASTM C94/C94M, using **3/4 inch** maximum size aggregate, and having minimum compressive strength of **3000 psi** at 28 days. Use grout consisting of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

PART 3 EXECUTION

3.1 PREPARATION

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](#). Set terminal (corner, gate, and pull) posts whenever abrupt changes in vertical and horizontal alignment are encountered. Provide continuous fabric between terminal posts; however, ensure runs between terminal posts do 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

Excavate holes to depths indicated. Clear all post holes of loose material and spread waste material where directed. Eliminate ground surface irregularities along the fence line to the extent necessary to maintain a [2 inch](#) clearance between the bottom of the fabric and finish grade.

3.2 INSTALLATION

3.2.1 Installation Drawings

Submit complete [Fence Installation Drawings](#) for review and approval by the Contracting Officer prior to shipment. Submit drawing details that include, but are not limited to the following information: Fence Installation Drawings, Location of gate, corner, end, and pull posts, Gate Assembly, Turnstiles, and [Gate Hardware and Accessories](#). Install fence system per approved drawings.

3.2.2 Security Fencing

Install new security fencing, remove existing security fencing, and perform related work to provide continuous security for facility. Schedule and fully coordinate work with Contracting Officer.

3.2.3 Posts

3.2.3.1 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. Set portions of posts not set in rock in concrete from the rock to ground level. Set posts 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. Ensure post movement measured at the point where the force is applied is 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. Remove, replace, and retest all failed parts at the Contractor's expense.

3.2.3.2 Concrete Slabs and Walls

When installed in concrete slabs or walls, set posts in zinc-coated sleeves, to a minimum depth of 12 inches. Fill sleeve joint with lead, nonshrink grout, or other approved material. Set posts for support of removable fence sections in sleeves that provide a tight sliding joint and hold posts aligned and plumb without use of lead or setting material.

3.2.4 Gate Installation

- a. Install gates at the locations shown. Mount gates to swing as indicated. Install latches, stops, and keepers as required.

3.2.5 Grounding

- a. Provide ground conductor consisting of No. 8 AWG solid copper wire. Use grounding electrodes that measures 3/4 inch by 10 foot long and are a 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, bury electrodes a minimum of 12 inches deep and radially from the fence. Install the top of the electrode to 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. Measure total resistance of the fence to ground and ensure it is not greater than 25 ohms.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Cleanup

Remove waste fencing materials and other debris from the work site each workday.

-- End of Section --

SECTION 32 92 23

SODDING

04/06, CHG 1: 08/21

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.

ASTM INTERNATIONAL (ASTM)

ASTM C602 (2020) Agricultural Liming Materials

ASTM D4972 (2018) Standard Test Methods for pH of Soils

TURFGRASS PRODUCERS INTERNATIONAL (TPI)

TPI GSS (1995) Guideline Specifications to Turfgrass Sodding

U.S. DEPARTMENT OF AGRICULTURE (USDA)

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

100 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 31 23 00.00 20 EXCAVATION AND FILL 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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

Topsoil composition tests (reports and recommendations).

SD-07 Certificates

Sod farm certification for sods. Indicate type of sod in accordance with TPI GSS.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Sod 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 Sod Storage

Lightly sprinkle with water, cover with moist burlap, straw, or other approved covering; and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that internal heat will not develop. Do not store sod longer than 24 hours. Do not store directly on concrete or bituminous surfaces.

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 Sod

Place sod a maximum of thirty six hours after initial harvesting, in accordance with TPI GSS as modified herein.

PART 2 PRODUCTS

2.1 SODS

2.1.1 Classification

Centipede sod, nursery grown, certified as classified in the TPI GSS. Machine cut sod at a uniform thickness of 3/4 inch within a tolerance of 1/4 inch, excluding top growth and thatch. Each individual sod piece shall be strong enough to support its own weight when lifted by the ends. Broken pads, irregularly shaped pieces, and torn or uneven ends will be rejected. Wood pegs and wire staples for anchorage shall be as recommended by sod supplier.

2.1.2 Purity

Sod species shall be genetically pure, free of weeds, pests, and disease.

2.1.3 Composition

2.1.3.1 Sod Farm Overseeding

At the sod farm provide sod with overseeding of annual rye grass seed.

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 entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall 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 shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Other components shall conform to the following limits:

Silt	25-50 percent
Clay	10-30 percent
Sand	20-35 percent

pH	5.5 to 7.0
Soluble Salts	600 ppm maximum

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 hydrate limestone containing a calcium carbonate equivalent (C.C.E.) as specified in [ASTM C602](#) of not less than [110](#) percent.

2.4 FERTILIZER

2.4.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

- [10](#) percent available nitrogen
- [10](#) percent available phosphorus
- [10](#) percent available potassium

2.5 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation containing no element toxic to plant life.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Extent Of Work

Provide soil preparation (including soil conditioners), fertilizing, and sodding 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.

3.1.2 Soil Preparation

Provide [4 inches](#) of off-site topsoil [or](#) on-site topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer 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.

3.1.2.1 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Lime 200 pounds per acre.

3.2 SODDING

3.2.1 Finished Grade and Topsoil

Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL.

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove from the surface debris and stones over a minimum 5/8 inch in any dimension.

3.2.2 Placing

Place sod a maximum of 36 hours after initial harvesting, in accordance with TPI GSS as modified herein.

3.2.3 Sodding Slopes and Ditches

For slopes 2:1 and greater, lay sod with long edge perpendicular to the contour. For V-ditches and flat bottomed ditches, lay sod with long edge perpendicular to flow of water. Anchor each piece of sod with wood pegs or wire staples maximum 2 feet on center. On slope areas, start sodding at bottom of the slope.

3.2.4 Finishing

After completing sodding, blend edges of sodded area smoothly into surrounding area. Air pockets shall be eliminated and a true and even surface shall be provided. Frayed edges shall be trimmed and holes and missing corners shall be patched with sod.

3.2.5 Rolling

Immediately after sodding, 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.

3.2.6 Watering

Start watering areas sodded as required by daily temperature and wind conditions. Apply water at a rate sufficient to ensure thorough wetting of soil to minimum depth of 6 inches. Run-off, puddling, and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or plant material shall be prevented.

3.3 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations. 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING
02/18, CHG 1: 02/22

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 B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
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

AMERICAN WATER WORKS ASSOCIATION (AWWA)

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 C105/A21.5	(2018) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) 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	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C219	(2017) Bolted Sleeve-Type Couplings for

Plain-End Pipe

AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C502	(2018) Dry-Barrel Fire Hydrants
AWWA C508	(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS
AWWA C509	(2015) Resilient-Seated Gate Valves for Water Supply Service
AWWA C515	(2020) 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	(2021) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVC0) Pressure Pipe and Fittings
AWWA C651	(2014) Standard for Disinfecting Water Mains
AWWA C655	(2009) Field Dechlorination
AWWA C800	(2021) 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 M9	(2008; Errata 2013) Manual: Concrete Pressure Pipe
AWWA M23	(2020) Manual: PVC Pipe - Design and Installation - Third Edition
AWWA M41	(2009; 3rd Ed) Ductile-Iron Pipe and Fittings
AWWA M55	(2020; 2nd Ed) PE Pipe - Design and Installation

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2003; R 2021) Standard Specification for Gray Iron Castings
ASTM A126	(2004; R 2019) Standard Specification for Gray Iron Castings for Valves, Flanges,

and Pipe Fittings

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 B61	(2015; R 2021) Standard Specification for Steam or Valve Bronze Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM C94/C94M	(2022a) 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 D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
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	(2021) Underground Installation of Thermoplastic Pressure Piping
ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F402	(2005; R 2012) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

ASTM F477 (2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

ASTM F1674 (2011) Standard Test Method for Joint Restraint Products for Use with PVC Pipe

ASTM F2164 (2018) Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure

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

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-80 (2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24 (2022) Standard for the Installation of Private Fire Service Mains and Their Appurtenances

NSF INTERNATIONAL (NSF)

NSF/ANSI 14 (2021) Plastics Piping System Components and Related Materials

NSF/ANSI 61 (2022) Drinking Water System Components - Health Effects

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-600-01 (2016; with Change 6, 2021) Fire Protection Engineering for Facilities

UNDERWRITERS LABORATORIES (UL)

UL 246 (2011; Reprint Jul 2020) UL Standard for Safety Hydrants for Fire-Protection Service

UL 262 (2004; Reprint Oct 2011) Gate Valves for Fire-Protection Service

UL 312 (2022) UL Standard for Safety Check Valves for Fire-Protection Service

UL 789 (2004; Reprint May 2017) UL Standard for Safety Indicator Posts for Fire-Protection

Service

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-PUB-08

(2016) Tapping Guide for PVC Pressure Pipe

1.2 DEFINITIONS

1.2.1 Water Transmission Mains

Water transmission mains include water piping having diameters greater than 14 inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.2.2 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.

1.2.3 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.

1.2.4 Additional Definitions

For additional definitions refer to the definitions in the applicable referenced standard.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Connections; G

SD-03 Product Data

Pipe, Fittings, Joints and Couplings; G

Valves; G

Valve Boxes; G

Fire Hydrants; G

Pipe Restraint; G

Tapping Sleeves; G

Corporation Stops; G

Backflow Preventer; G

Disinfection Procedures; G

Indicator Posts; G

Service Saddle; G

SD-06 Test Reports

Backflow Preventer Tests; G

Bacteriological Samples; G

Leakage Test; G

Hydrostatic Test; G

SD-07 Certificates

Pipe, Fittings, Joints and Couplings; G

Shop-Applied Lining; G

Lining; G

Lining for Fittings; G

Lining for Ductile Iron Fittings; G

Valves; G

Fire Hydrants; G

Backflow Prevention Training Certificate; G

Backflow Tester Certification; G

Backflow Certificate; G

SD-08 Manufacturer's Instructions

Ductile-Iron Piping; G

PVC Piping; G

PVC Piping For Service Lines; G

Polyethylene (PE) Piping And Tubing For Service Lines; G

1.4 QUALITY CONTROL

1.4.1 Regulatory Requirements

Use **NSF/ANSI 61** or **NSF/ANSI 14** materials for potable water systems to comply with lead free content requirements as defined by the U.S. Safe Drinking Water Act effective January 2014.

Comply with **NFPA 24** for materials, installation, and testing of fire main

piping and components.

1.4.2 Qualifications

1.4.2.1 Backflow Preventers

1.4.2.1.1 Backflow Preventer Certificate

Certificate of Full Approval from [FCCCHR List](#), University of Southern California, attesting that the design, size and make of each backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. Certificate of Provisional Approval will not be acceptable.

1.4.2.1.1.1 Backflow Tester Certificate

Prior to testing, submit to the Contracting Officer certification issued by the State or local regulatory agency attesting that the [backflow tester](#) has successfully completed a certification course sponsored by the regulatory agency.

1.4.2.1.1.2 Backflow Prevention Training Certificate

Submit a certificate recognized by the State or local authority that states the Contractor has completed at least 10 hours of training in backflow preventer installations. The certificate must be current.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

Inspect materials delivered to site for required pipe markings and damage. Unload and store with minimum handling and in accordance with manufacturer's instructions to prevent cuts, scratches and other damage. 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 or other contaminants.

1.5.2 Handling

Handle pipe, fittings, valves, [fire hydrants](#), and other accessories in accordance with applicable AWWA standard, 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 pipe, fittings, and accessories in

accordance with AWWA C605.

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.

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, 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 for pipe and fittings unless otherwise indicated. Provide mechanical joints where indicated. Provide flanged joints where indicated. Provide insulating joints where indicated.

- 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: Bolts, nuts, and gaskets for flanged connections as recommended in Appendix A of AWWA C115/A21.15. Provide AWWA C115/A21.15 ductile iron flanges and conform to ASME B16.1, Class 125
- 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.

2.1.1.1.2 Plastic Piping

2.1.1.1.2.1 PVC Piping

2.1.1.1.2.1.1 PVC Piping

AWWA C900 plain end or gasket bell end pipe meeting or exceeding ASTM D1784 cell class 12454, with a minimum Pressure Class 235 (DR 18) with ductile iron outside diameter (DIOD).

2.1.1.1.2.1.2 Fittings for PVC Pipe

Ductile iron fittings, AWWA C110/A21.10 or compact fittings in accordance with 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.

2.1.1.1.2.1.3 Joints and Jointing Material for PVC Piping

- 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.

2.1.1.1.2.2 PVC Piping for Service Lines

2.1.1.1.2.2.1 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.

2.1.1.1.2.2.2 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.

2.1.2 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

Gate valves open by counterclockwise rotation of the valve stem. Stuffing boxes have O-ring stem seals. Stuffing boxes are bolted and constructed so as to permit easy removal of parts for repair. 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 have ends compatible with joining to the pipe used. Provide all valves from one manufacturer.

2.1.2.2 Reduced Pressure Double Check Valve Assembly

The reduced pressure backflow preventer shall consist of two independently operating, spring loaded cam-check valves with a hydraulically operated differential pressure relief valve located between and below the cam-checks, required test cocks and inlet and outlet resilient seat shut off valves. When normal flow exists, both check valves are open and the pressure in the area between the checks, called the zone, is at least 2 psi lower than the inlet pressure. The differential pressure relief valve is closed during normal flow.

If cessation of normal flow occurs, the differential pressure relief valve will automatically open and discharge to maintain the zone at least 2 psi lower than the inlet pressure. This action will prevent a backflow or backsiphonage condition. After the required differential is established, the differential pressure relief valve again closes.

The cam-checks include a stainless steel spring and cam-arm, rubber faced disc and a replaceable seat. The body shall be manufactured from 300 series stainless steel, lead free, with a single two-bolt grooved style access cover. No special tools shall be required for servicing. The relief valve shall be compact with a rolling diaphragm and no sliding seals. The relief valve shall discharge in a 360 degree radius.

The assembly shall have a rated working pressure of 175 psi and a rated hydrostatic pressure of 350 psi.

The assembly shall meet the American Society of Sanitary Engineering (ASSE) Standard and carry the ASSE seal or appear on the University of California approval list.

2.1.2.3 Check Valves

Provide a protective interior coating in accordance with AWWA C550. Swing-check type, AWWA C508 or UL 312 and:

- a. AWWA C508: Iron or steel body and cover and flanged ends
- b. UL 312: Cast iron or steel body and cover, flanged ends, and designed for a minimum working pressure of 150 psi.

Materials for UL 312 check valves are to match the reference standards specified in AWWA C508. Provide check valves with a clear port opening. Provide spring-loaded check valves. Provide all check valves from one manufacturer.

2.1.2.4 Water Service Valves

2.1.2.4.1 Gate Valves Smaller than 3 Inch in Size on Buried Piping

Gate valves smaller than 3 inch size on Buried Piping MSS SP-80, Class 150, solid wedge, nonrising stem, with flanged or threaded end connections, a union on one side of the valve, and a handwheel operator.

2.1.2.4.2 Gate Valves Smaller Than 3 Inch Size in Valve Pits

MSS SP-80, Class 150, solid wedge, inside screw, rising stem. Provide valves with flanged or threaded end connections, a union on one side of the valve, and a handwheel operator.

2.1.2.4.3 Check Valves Smaller than 2 Inch in Size

Provide check valves with a minimum working pressure of 150 psi or as indicated with a clear waterway equal to the full nominal diameter of the valve. Valves open to permit flow when inlet pressure is greater than the discharge pressure, and close tightly to prevent return flow when discharge pressure exceeds inlet pressure. Cast the size of the valve, working pressure, manufacturer's name, initials, or trademark on the body of each valve.

Provide valves for screwed fittings, made of lead-free bronze and in conformance with MSS SP-80, Class 150, Types 3 and 4 compatible for the application.

2.1.2.5 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. Provide a round head. Cast the word "WATER" on the lid. The minimum diameter of the shaft of the box is 5 1/4 inches.

2.1.3 Fire Hydrants and Hose Houses

2.1.3.1 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](#).

2.1.3.1.1 Dry-Barrel Type Fire 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.

Provide mechanical-joint end only inlet, except where flanged end is indicated; with end matching requirements as specified in [AWWA C502](#) 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](#). Provide fire hydrant with special couplings joining upper and lower sections of fire hydrant barrel that break from a force imposed by a moving vehicle.

[Provide 5-inch Storz connection with cap and chain at all fire hydrants.](#)

2.1.4 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.

2.2.1.2 Joint Restraint

Provide restrained joints in accordance with [NFPA 24](#), Chapter 10 and in accordance with [ASTM F1674](#).

Provide mechanical joint restraint or metal harness fabricated by the pipe manufacturer.

2.2.2 Tapping Sleeves

[Body: 304 Stainless Steel.](#)

[Bolts and Nuts: 304 Stainless Steel.](#)

[Gaskets: Gaskets are made of virgin Styrene Butadiene Rubber \(SBR\) compounded for water and sewer service in accordance with ASTM D2000 3 BA715.](#)

[Pressure: Saddle shall be suitable for a maximum working pressure of 150 psi and a maximum hydrostatic pressure of 200 psi.](#)

[Standards: The service saddle shall meet the requirements of ANSI/AWWA C800.](#)

2.2.2.1 Indicator Posts

Provide upright gate valve with indicator post in accordance with UL 789 and NFPA 24, where indicated. Construct indicator post body of cast iron, ductile iron or a combination of both, bronze operating nut, cast iron locking wrench meeting the requirements of ASTM A126 Class B, with open and shut target window.

2.2.3 Sleeve-Type Mechanical Couplings

Use AWWA C219 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, use ASTM A536 ductile iron. 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 ASTM A563, Grade A nuts or round-head square-neck type ASME B18.5.2.2M or ASME B18.5.2.1M bolts with ASME B18.2.2 hex nuts. Provide 5/8 inch diameter bolts. Minimum number of bolts for each coupling is 5 for 6 inch pipe, 7 for 10 inch pipe, and 8 for 12 inch pipe. 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.

2.2.4 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.

2.2.5 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.

2.2.6 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.

2.2.7 Water Service Line Appurtenances

2.2.7.1 Corporation Stops

Ground key type; lead-free bronze, ASTM B61 or ASTM B62; compatible with

the working pressure of the system and solder-joint, or flared tube compression type joint. Threaded ends for inlet and outlet of corporation stops, AWWA C800; coupling nut for connection to flared copper tubing, ASME B16.26.

2.2.7.2 Curb or Service Stops

Ground key, round way, inverted key type; made of lead-free bronze, ASTM B61 or ASTM B62; and compatible with the working pressure of the system. Provide compatible ends for connection to the service piping. Cast an arrow into body of the curb or service stop indicating direction of flow.

2.2.7.3 Service Clamps

Provide single or double flattened strap type service clamps used for repairing damaged cast-iron, steel or PVC pipe with a pressure rating not less than that of the pipe being repaired. Provide clamps with a galvanized malleable-iron body with cadmium plated straps and nuts and a rubber gasket cemented to the body.

2.2.7.4 Curb Boxes

Provide a curb box for each curb or service stop manufactured from cast iron, size capable of containing the stop where it is used. Provide a round head. Cast the word "WATER" on the lid. Factory coat the box with a heavy coat of bituminous paint.

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 23 00.00 20 EXCAVATION AND FILL.

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. Do not install copper tubing in the same trench with ferrous piping materials. 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 3 feet depth of cover over top of pipe.

3.2.1.1.3 Tracer Wire

Install a continuous length of tracer wire for the full length of each run of metallic and 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

Lay water piping at least 10 feet horizontally from a sewer or sewer manhole whenever possible. Measure the distance edge-to-edge.

Unusual Conditions: When local conditions or barriers prevent a 10-foot lateral separation, then:

- (1) The water main shall be laid in a separate trench and the bottom (invert) of the water piping shall be at least 18 inches above the top (crown) of the sewer piping. The water main can be laid in the same trench; however, the water main shall be laid on the opposite side of the trench on an undisturbed bench constructed 18-inches above the top of the sewer pipe.
- (2) Where the horizontal separation cannot be obtained, the sewer and water piping shall be constructed of AWWA-ferrous pipe. All pipe shall be pressure tested in place without leakage prior to backfilling.
- (3) The sewer manhole shall be of watertight construction and tested in place.

3.2.1.1.7 Water Piping Crossing Sewer Piping

- (1) Normal Conditions: Water piping shall be laid to cross above sewer piping with a separation of at least 18 inches between the bottom of the water piping and the top of the sewer piping.
- (2) Unusual Conditions: When local conditions prevent a vertical separation as described above, use the following construction:
 - (a) Water piping passing over sewer piping without a vertical separation of at least 18 inches between the top of the sewer piping and the bottom of the water piping; the provide adequate structural support for the water piping to prevent excessive deflection of the joints and the settling on and breaking of the sewer piping; and both the water piping and sewer piping shall be constructed of AWWA ferrous materials with joints equivalent to water main standards for a minimum distance of 10 feet on each side of the point of crossing. For water and sewer mains, a 20 foot minimum section of AWWA ferrous piping shall be centered at the point of crossing so that joints shall be equidistant and as far as possible from the sewer piping.
 - (b) Water piping passing under sewer piping shall, in addition, be protected by providing a vertical separation of at least 18 inches between the bottom of the sewer piping and the top of the water piping; providing adequate structural support for the sewer piping to prevent excessive deflection of the joints and the settling on and breaking of the water piping; and both the water piping and sewer piping shall be constructed of AWWA ferrous materials with joints equivalent to water main standards for a minimum distance of 10 feet on each side of the point of crossing. For water and sewer mains, a 20 foot minimum section of AWWA ferrous piping shall be centered at the point of crossing that joints shall be equidistant and as far as possible from the sewer piping.
 - (c) Sewer Piping or Sewer Manholes: No water piping shall pass

through or come in contact with any part of a sewer manhole.

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.

3.2.1.2 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 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. 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.
- c. Exterior Protection: Completely encase buried ductile iron pipelines using Method C, with polyethylene film, in accordance with AWWA C105/A21.5.

3.2.1.3 PVC and PVC0 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 Plastic Service Piping

Install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the applicable requirements of [ASTM D2774](#) and [ASTM D2855](#), unless otherwise specified. Handle solvent cements used to join plastic piping in accordance with [ASTM F402](#).

3.2.1.4.1 Jointing

Make solvent-cemented joints for PVC piping using the solvent cement previously specified for this material; assemble joints in accordance with [ASTM D2855](#). Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.2.1.4.2 Plastic Pipe Connections to Appurtenances

Connect plastic service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.

3.2.1.5 Water Service Piping

3.2.1.5.1 Location

3.2.1.5.2 Water Service Line Connections to Water Mains

Connect water service lines to the main with a rigid connection and install a gate valve on service line below the frostline as indicated. Connect water service lines to ductile-iron water mains in accordance with

AWWA C600 for service taps. Connect water service lines to PVC water mains in accordance with UBPPA UNI-PUB-08 and the recommendations of AWWA M23, Chapter 9, "Service Connections."

3.2.2 Meters

Install meters and meter boxes at the locations shown on the drawings. Center meters in the boxes to allow for reading and ease of removal or maintenance. Set top of box or vault at finished grade.

3.2.3 Backflow Preventers

Install backflow preventers of type, size, and capacity indicated a minimum of 12 inch and a maximum of 36 inch above concrete base. Include valves and test cocks. Install according to the manufacturers requirements and the requirements of plumbing and health department and authorities having jurisdiction. Support NPS 2 1/2 inch and larger backflow preventers, valves, and piping near floor with 12 inch minimum air gap, and on concrete piers or steel pipe supports. Do not install backflow preventers that have a relief drain in vault or in other spaces subject to flooding. Do not install by-pass piping around backflow preventers.

3.2.4 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 continuous-feed method of chlorination. Ensure a free chlorine residual of not less than 10 parts per million after 24 hour holding period and prior to performing bacteriological tests.

3.2.5 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. Water generated from the flushing of lines after disinfection or disinfection with hydrostatic testing must be land-applied in accordance with federal, state and local laws and regulations for land application. **No water used for disinfection and testing shall be allowed to enter the domestic water or sewer systems.**

3.2.6 Pipe Restraint

3.2.6.1 Concrete Thrust Blocks

Install concrete thrust blocks where indicated.

3.2.6.2 Restrained Joints

Install restrained joints in accordance with the manufacturer's instructions where indicated. For metal harness use tie rods and clamps as shown in NFPA 24. Provide metal harness fabricated by the pipe manufacturer and furnished with the pipe.

3.2.7 Valves

3.2.7.1 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 and [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.

3.2.7.2 Check Valves

Install check valves in accordance with the applicable requirements of [AWWA C600](#) for valve-and-fitting installation, except as otherwise indicated. Make and assemble joints to check valves as specified for making and assembling the same type joints between pipe and fittings.

3.2.7.3 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.

3.2.8 Fire Hydrants

Install fire hydrants, except for metal harness, 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 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 water mains and water service lines in accordance with the applicable specified standard, except for the special testing requirements given in paragraph entitled "Special Testing Requirements." Test ductile-iron

water mains and water service lines 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 shall not exceed the amounts given in AWWA C600; no leakage will be allowed at joints made by any other method.

The maximum allowable leakage shall be as determined by the following formula:

$$L = (S \times D \times (P)^{1/2}) / 148,000$$

Where L = allowable leakage over the two hour test period in gallons per hour, S = length of the tested section in feet, D = diameter of the pipe in inches, and P = test pressure in psi.

3.3.1.1.1 Special Testing Requirements

For pressure test, use a hydrostatic pressure 50 psi greater than the maximum working pressure of the system, except that for those portions of the system having pipe size larger than 2 inches in diameter, hydrostatic test pressure shall be not less than 200 psi. Hold this pressure for not less than 2 hours. Prior to the pressure test, fill that portion of the pipeline being tested with water for a soaking period of not less than 24 hours. 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.

3.3.1.2 Hydrostatic Sewer Test

The hydrostatic pressure sewer test will be performed in accordance with the applicable AWWA standard for the piping material or AWWA C600.

3.3.1.3 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.

For PE pipe perform leak testing in accordance with AWWA M55, ASTM F2164.

3.3.1.4 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 North Carolina certified laboratory, and submit the results of the bacteriological samples.

3.3.1.5 Backflow Preventer Tests

After installation conduct Backflow Preventer Tests and provide test reports verifying that the installation meets the FCCCHR Manual Standards.

3.3.1.6 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

3.3.1.7 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.

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 --

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 C94/C94M	(2022a) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM D2321	(2020) 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 F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F949	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

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" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's License; G

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Pipeline Materials; G

Gravity Pipe; G

SD-06 Test Reports

Hydrostatic Sewer Test; G

Low-Pressure Air Tests; G

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 53](#) MISCELLANEOUS 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 of polyvinyl chloride (PVC) plastic pipe. Provide building connections 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.

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 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.

2.2.3 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.

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. [Install pressure sewer lines beneath water lines only, with the top of the sewer line being at least 2 feet below bottom of water line.](#) When these separation distances can not be met, contact the Contracting Officer for direction.

3.2.2.1.1 Sanitary Piping Installation Parallel with Water Line

3.2.2.1.1.1 Normal Conditions

[Install sanitary piping or manholes at least 10 feet horizontally from a water line whenever possible. Measure the distance from edge-to-edge.](#)

3.2.2.1.1.2 Unusual Conditions

[When local conditions prevent a horizontal separation of 10 feet, the sanitary piping or manhole may be laid closer to a water line provided that:](#)

- [a. The top \(crown\) of the sanitary piping is to be at least 18 inches below the bottom \(invert\) of the water main.](#)
- [b. Where this vertical separation cannot be obtained, construct the sanitary piping with AWWA-approved ductile iron water pipe pressure and conduct a hydrostatic sewer test without leakage prior to backfilling.](#)
- [c. The sewer manhole is to be of watertight construction and tested in](#)

place.

3.2.2.1.2 Installation of Sanitary Piping Crossing a Water Line

3.2.2.1.2.1 Normal Conditions

Lay sanitary sewer piping by crossing under water lines to provide a separation of at least 18 inches between the top of the sanitary piping and the bottom of the water line whenever possible.

3.2.2.1.2.2 Unusual Conditions

When local conditions prevent a vertical separation described above, use the following construction:

- a. Construct sanitary piping passing over or under water lines with AWWA-approved ductile iron water pressure piping and conduct a hydrostatic sewer test without leakage prior to backfilling.
- b. Protect sanitary piping passing over water lines by providing:
 - (1) A vertical separation of at least 18 inches between the bottom of the sanitary piping and the top of the water line.
 - (2) Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.
 - (3) That the length, minimum 20 feet, of the sanitary piping be centered at the point of the crossing so that joints are equidistant and as far as possible from the water line.

3.2.2.2 Earthwork

Perform earthwork operations in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL.

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 ends in the upgrade direction. Adjust spigots in bells 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.

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 Miscellaneous Construction and Installation

3.2.4.1 Connecting to Existing Manholes

Connect pipe to existing manholes such that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. Center the connection on the manhole. Holes for the new pipe are to be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cut the manhole in a manner that will cause the least damage to the walls.

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 Hydrostatic Sewer Test

When unusual conflicts are encountered between sanitary sewer and waterlines a hydrostatic pressure sewer test will be performed in accordance with the applicable AWWA standard for the piping material or AWWA C600.

3.3.1.2 Leakage Tests for Nonpressure Lines

Test lines for leakage by either infiltration tests and exfiltration 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.

3.3.1.2.1 Low-Pressure Air Tests

3.3.1.2.1.1 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 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE.

-- End of Section --

SECTION 33 40 00

STORMWATER UTILITIES

11/21

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.

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2003; R 2021) Standard Specification for Gray Iron Castings
ASTM A798/A798M	(2022) Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM A807/A807M	(2019) Standard Practice for Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
ASTM C76	(2020) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C76M	(2020) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C231/C231M	(2022) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C270	(2019a; E 2019) Standard Specification for Mortar for Unit Masonry
ASTM C443	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C443M	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C990M	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)

ASTM D1751	(2018) 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 D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
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 F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Pipe; G

Placing Pipe

Drainage Structures; G

SD-06 Test Reports

Hydrostatic Test on Watertight Joints; G

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Inspect materials delivered to site for damage and unload and store materials with minimal handling. Do not store materials directly on the ground. Keep the inside of pipes and fittings free of dirt and debris. 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. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe in accordance with the manufacturer's recommendations and discard if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

1.3.2 Handling

Handle materials in a manner that ensures delivery to the trench in sound, undamaged condition. Carry pipe to the trench.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe sizes for culverts and storm drains are indicated on the drawings.

2.1.1 Concrete Pipe

2.1.1.1 Reinforced Culvert and Storm Drain Pipe

Manufactured in accordance with and conforming to [ASTM C76M](#) [ASTM C76](#), Class V.

2.1.2 Poly Vinyl Chloride (PVC) Pipe

2.1.2.1 Type PSM PVC Pipe

[ASTM D3034](#), maximum SDR 35.

2.2 PIPE JOINTS

2.2.1 Concrete Pipe

2.2.1.1 Rubber Gasket Joints

Provide rubber gasket joints of a design and physical requirements conforming to [ASTM C443](#). Provide rubber gaskets that meet the oil resistant gasket requirements of [ASTM C443M](#) [ASTM C443](#).

2.2.1.2 Preformed Flexible Sealant Joints

Provide joints made with preformed flexible joint sealant conforming to [ASTM C990](#).

2.2.2 PVC Plastic Pipe

Provide solvent cement or elastomeric gasket type joints in accordance with the specification for the pipe and as recommended by the pipe manufacturer. Use solvent cement conforming to [ASTM D2564](#). Provide gaskets for elastomeric joints conforming to [ASTM F477](#).

2.3 MISCELLANEOUS MATERIALS

2.3.1 Concrete

Concrete shall have a minimum compressive strength of 3,000 psi at 28 days.

Provide air content by volume of concrete mixture, 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. Determine air content in accordance with [ASTM C231/C231M](#). Provide a minimum concrete covering over steel reinforcing of not less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. For concrete deposited directly against the ground, provide a covering thickness of at least 3 inches between steel and ground. Provide expansion-joint filler material conforming to [ASTM D1751](#), or [ASTM D1752](#), or provide be resin-impregnated fiberboard conforming to the physical requirements of [ASTM D1752](#).

2.3.2 Mortar

Mortar is not allowed for pipe joints. Provide mortar for pipe connections to drainage structures conforming to [ASTM C270](#), Type M, except that the maximum placement time will be 1 hour. Provide a sufficient quantity of water in the mixture to produce a stiff workable mortar but in no case may the quantity exceed 5 gallons of water per sack of cement. Use water that is clean and free of harmful acids, alkalis, and organic impurities. Use the mortar within 30 minutes after the ingredients are mixed with water.

2.3.3 Precast Reinforced Concrete Drainage Structures

Provide precast reinforced concrete manholes conforming to [NCDOT](#). Provide joints between precast concrete risers and tops that are full-bedded in cement mortar and smoothed to a uniform surface on both interior and exterior of the structure.

2.3.4 Frame and Cover or Gratings

Provide frame and cover or gratings made of cast gray iron, [ASTM A48/A48M](#), Class 35B; cast ductile iron. Stamp or cast the word "Storm Sewer" into covers so that it is plainly visible.

2.3.5 Downspout Boots

Use boots conforming to [ASTM A48/A48M](#), Class 30B or 35B of the size and shape indicated for connecting exterior downspouts to the storm-drainage system.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

2.4.1 Hydrostatic Test on Watertight Joints

2.4.1.1 Concrete, PVC Pipe

Provide joints in reinforced and nonreinforced concrete pipe meeting the performance requirements in [ASTM C990M](#) [ASTM C990](#) or [ASTM C443M](#) [ASTM C443](#). Provide joints in PVC, plastic pipe meeting the test requirements in [ASTM D3212](#).

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, AND DRAINAGE STRUCTURES

Excavate trenches, excavate for appurtenances and backfill for culverts and storm drains, in accordance with the applicable portions of Section [31 23 00.00 20 EXCAVATION AND FILL](#) and the requirements specified below.

3.1.1 Trenching

Excavate trenches to the width indicated on the drawings or as specified herein. Trench width should permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Place sheeting and bracing, where required, within the trench width as specified, without any overexcavation.

3.1.2 Removal of Rock

Replace rock in either ledge or boulder formation with suitable materials to provide a compacted earth cushion. Provide a compacted earth cushion between unremoved rock and the pipe with a thickness 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. Maintain the cushion under the bell as well as under the straight portion of the pipe where bell-and-spigot pipe is used. Provide a compacted earth cushion between unremoved rock and the box culvert of at least [8 inches](#) in thickness for concrete box culverts. Excavate rock as specified and defined in Section [31 23 00.00 20 EXCAVATION AND FILL](#).

3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe or box culvert, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, remove such material to the depth required and replace with select granular material to the proper grade. Compact select granular material as specified in paragraph FINAL BACKFILL. 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, perform such removal and replacement at no additional cost to the Government.

3.2 BEDDING AND INITIAL BACKFILL

Provide a firm bedding foundation of uniform density throughout the entire length of the pipe or box culvert.

3.2.1 Concrete Pipe

Use select granular material conforming to Section 31 23 00.00 20 EXCAVATION AND FILL for haunch and bedding material. Compact haunch and outer bedding to at least 90 percent laboratory maximum density and place in layers not exceeding 6 inch loose thickness for compaction by hand-operated compactors and 200 mm 8 inches for other than hand-operated machines. Loosely place middle bedding and do not compact. After the pipe has been properly bedded, place haunch material, at a moisture content that will facilitate compaction, evenly along both sides of the pipe and thoroughly compact each layer with mechanical tampers or rammers to the springline of the pipe. Thoroughly compact the haunch material under the haunches of the pipe. For bell and spigot pipe, form a depression in bedding material for bells so entire barrel of pipe is uniformly supported. Minimize the length, depth, and width of bell depressions to that required for properly making the particular type of joint.

3.2.1.1 Trenches

After the pipe has been properly bedded and haunch material placed to the midpoint (springline) of the pipe, backfill and compact the remainder of the trench by spreading and rolling or compacting by mechanical rammers or tampers in layers not exceeding 6 inches. Test for density as necessary to ensure conformance to the compaction requirements specified below. Leave untreated sheeting in place beneath structures or pavements.

3.2.2 Corrugated Steel and Aluminum Pipe

Provide bedding and structural backfill for corrugated steel and aluminum pipe and pipe arch in accordance with ASTM A798/A798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Structural backfill material consists of materials classified by ASTM D2487 as either GW, GM, GP-GM, GW-GM, GC, GP-GC or SW. Provide bedding for corrugated structural plate pipe meeting the requirements of ASTM A807/A807M.

3.2.3 Plastic Pipe

Provide bedding for PVC, PE, SRPE and PP pipe meeting the requirements of ASTM D2321. Use Class IB or II material for PVC, PE, SRPE pipe bedding, haunching, and initial backfill. Use Class I, II, or III material for PP pipe bedding, haunching and initial backfill.

3.3 PLACING PIPE

Submit printed copies of the pipe or box culvert manufacturer's recommended pipe or box culvert installation procedures prior to installation. Thoroughly examine each section of pipe or box culvert before being laid; do not use defective or damaged pipe. Protect plastic pipe, excluding SRPE pipe, from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Lay pipelines to the grades and alignment indicated. Provide proper facilities for lowering sections of pipe into trenches. Place lifting lugs in vertically elongated corrugated steel or aluminum pipe in the same vertical plane as the major axis of the pipe. Do not lay pipe in water or when trench conditions or weather are unsuitable for such work. Divert drainage or dewater trenches during

construction as necessary. Deflection of installed flexible pipe must not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (percent)
Plastic (PVC)	5

3.3.1 Concrete, PVC Pipe

Lay pipe proceeding 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 Pipe

3.4.1.1 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe and Box Culverts

Follow the recommendation of the particular manufacturer in regard to sealing compound special installation requirements. When lubricants, primers, or adhesives are used, only apply on surfaces that are dry and clean. Affix sealing compounds to the pipe or box culvert not more than 3 hours prior to installation of the pipe or box culvert. Protect sealing compounds from the sun, blowing dust, and other deleterious agents at all times. Inspect sealing compounds before installation of the pipe or box culvert, and remove and replace any loose or improperly affixed sealing compound. Align the pipe or box culvert with the previously installed pipe or box culvert, and pull the joint together.

3.4.1.2 Flexible Watertight Joints

Use lubricants, cements, adhesives, and other special installation requirements for gaskets and jointing materials as recommended by the manufacturer. When lubricants, cements, or adhesives are used, only apply on surfaces that are clean and dry. Affix gaskets and jointing materials to the pipe not more than 24 hours prior to the installation of the pipe, and protect from the sun, blowing dust, and other deleterious agents at all times. Inspect gaskets and jointing materials before installing the pipe; remove and replace any loose or improperly affixed gaskets and jointing materials. Align the pipe with the previously installed pipe, and push the joint home. If the gasket becomes visibly dislocated when joining sections of pipe, remove the pipe and remake the joint.

3.5 DRAINAGE STRUCTURES

3.5.1 Inlets

Construct manholes of precast reinforced concrete. Construct inlets of precast reinforced concrete. Provide manholes and inlets complete with frames and covers or gratings. Make pipe connections to concrete manholes and inlets with flexible, watertight connectors.

3.6 INSTALLATION OF TRACER WIRE AND WARNING TAPE

Install warning tape above all storm drain pipe in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL.

3.7 FINAL BACKFILL

Backfill trenches with satisfactory material deposited in layers of a maximum of 8 inches loose thickness and compacted to 90 percent of maximum density for cohesive soils and 95 percent of maximum density for cohesionless soils in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL. Testing is the responsibility of the Contractor and will be performed at no additional cost to the Government. Unless otherwise specified, determine field in-place density of final backfill at a frequency of one test per 50 linear feet, or fraction thereof, of each lift of backfill. Submit test results in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL. Do not displace or damage pipe or box when compacting final backfill by rolling or operating heavy equipment parallel with the pipe or box. Movement of construction machinery over a culvert or storm drain at any stage of construction will be at the Contractor's risk. Repair or replace any damaged pipe. Protect concrete pipes with a minimum of 3 feet of cover prior to permitting heavy construction equipment to pass over them during construction.

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.

3.8.2 Inspection

3.8.2.1 Post-Installation Inspection

Inspect each segment of 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 Pipe

An engineer must evaluate all pipes with cracks with a width greater than 0.25 mm 0.01 inches, but less than 0.10 inches to determine if any remediation or repair is required.

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 Inspection

Replace pipe or repair defects indicated in the Post-Installation Inspection Report.

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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 33 71 01

OVERHEAD TRANSMISSION AND DISTRIBUTION
05/19, CHG 1: 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.

ASTM INTERNATIONAL (ASTM)

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 B3	(2013) Standard Specification for Soft or Annealed Copper Wire
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B398/B398M	(2015; R 2021) Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes
ASTM B399/B399M	(2004; R 2021) Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
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 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.42	(2016) Specifications for High-Voltage (> 1000 V) Fuses and Accessories
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power

Circuits (>1kV)

IEEE C135.22

(1988) Standard for Zinc-Coated Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS

(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC 74/ICEA S-93-639

(2012) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

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

(2023) 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

UNDERWRITERS LABORATORIES (UL)

UL 6

(2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel

UL 467

(2022) UL Standard for Safety Grounding and Bonding Equipment

UL 486A-486B

(2018; Reprint May 2021) UL Standard for Safety Wire Connectors

UL 510

(2020) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape

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, must be as defined in IEEE 100.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Conductors; G

Insulators; G

Cutouts; G

Surge Arresters; G

SD-06 Test Reports

Field Quality Control; G

Ground Resistance Test Reports; G

Medium-Voltage Preassembled Cable Test; G

Sag and Tension Test; G

Acceptance Checks and Tests; G

SD-09 Manufacturer's Field Reports

Operation and Maintenance Manuals; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals, Data Package 5; G

1.5 QUALITY ASSURANCE

1.5.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory except of NFPA 70 when more stringent requirements are specified or indicated, 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 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 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 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 must 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.

1.6 OPERATIONS AND MAINTENANCE DATA

Provide [operation and maintenance manuals](#) for systems in accordance with Section [01 78 23](#) OPERATION AND MAINTENANCE DATA that provides basic data relating to the design, operation, and maintenance of the electrical distribution system.

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 must be visually inspected by the Contractor when received and prior to acceptance from conveyance. Protect stored items from the environment in accordance with the manufacturer's published instructions. Replace damaged items. Store oil filled transformers and switches in accordance with the manufacturer's requirements.

1.8 WARRANTY

The equipment items must 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. Provide equipment and component items, not hot-dip galvanized or porcelain enamel finished, with corrosion-resistant finishes which must 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. Provide the described test mark and test evaluation in accordance with [ASTM D1654](#) with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Coat cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel with a zinc rich paint conforming to the manufacturer's standard.

2.2 CROSSARMS AND BRACKETS

2.2.1 Armless Construction

Pole mounting brackets for line-post or pin insulators and eye bolts for suspension insulators must be as indicated. Brackets must 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 must be suitable for the shape of the pole. Brackets for wood poles must have wood gripping members. Horizontal offset brackets must have a 5-degree uplift angle. Pole top brackets must conform to [IEEE C135.22](#), except for modifications necessary to provide support for a line-post insulator. Brackets must provide a strength exceeding that of the required insulator strength, but in no case less than a [2800 pound](#) cantilever strength.

2.3 HARDWARE

Hardware must be hot-dip galvanized in accordance with [ASTM A153/A153M](#) and [ASTM A123/A123M](#).

2.4 INSULATORS

Provide wet-process porcelain insulators which are radio interference free.

- a. Line post type insulators: [NEMA/ANSI C29.7](#), Class [15 kV](#).

2.5 OVERHEAD CONDUCTORS, CONNECTORS AND SPLICES

[Conductors](#) of bare aluminum alloy (AAAC) of sizes and types indicated. Where aluminum conductors are connected to dissimilar metal, fittings conforming to [UL 486A-486B](#) must be used.

2.5.1 Aluminum Alloy (AAAC)

[ASTM B398/B398M](#) or [ASTM B399/B399M](#).

2.5.2 Connectors and Splices

Connectors and splices must 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 must comply with [UL 486A-486B](#).

2.6 GROUNDING AND BONDING

2.6.1 Driven Ground Rods

Provide cone pointed 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.

2.6.2 Grounding Conductors

[ASTM B3](#). Provide soft drawn copper wire ground conductors a minimum No. 4 AWG. Ground wire protectors must be PVC. Keep ground conductors straight and short. Minimize bends in all ground connections.

2.6.3 Grounding Connections

[UL 467](#). Exothermic weld or compression connector.

2.7 SURGE ARRESTERS

[IEEE C62.11](#), metal oxide, polymeric-housed, surge arresters arranged for equipment mounting. RMS voltage rating must be 10 kV. Arresters must be Distribution class.

2.8 FUSED CUTOUPS

Open type fused cutouts rated 100 amperes and amperes symmetrical interrupting current at 15 kV ungrounded, conforming to [IEEE C37.42](#). Type K 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.

2.9 CONDUIT RISERS AND CONDUCTORS

The riser shield must be PVC containing a PVC back plate and PVC extension shield or 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](#).

2.10 ELECTRICAL TAPES

Tapes must be UL listed for electrical insulation and other purposes in wire and cable splices. Terminations, repairs and miscellaneous purposes, electrical tapes must comply with [UL 510](#).

2.11 CAULKING COMPOUND

Compound for sealing of conduit risers must be of a puttylike consistency workable with hands at temperatures as low as [35 degrees F](#), must not slump at a temperature of [300 degrees F](#), and must not harden materially when exposed to air. Compound must readily caulking or adhere to clean surfaces of the materials with which it is designed to be used. Compound must 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 medium 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. Consider street, alleys, roads and drives "public." Pole configuration must be as indicated.

3.1.1 Hardware

Provide hardware with washer against wood and with nuts and lock nuts applied wrench tight. Provide locknuts on threaded hardware connections. Locknuts must be M-F style and not palnut style.

3.1.2 Grounding

Unless otherwise indicated, grounding must conform to **IEEE C2** and **NFPA 70**.

Pole grounding electrodes must 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 must apply.

3.1.2.1 Grounding Electrode Installation

Install grounding electrodes as follows:

- a. Driven rod electrodes - Unless otherwise indicated, locate ground rods approximately **3 feet** out from base of the pole and drive into the earth until the tops of the rods are approximately **one foot** below finished grade. Evenly spaced multiple rods at least **10 feet** apart and connected together **2 feet** below grade with a minimum No. 6 bare copper conductor.
- b. Plate electrodes - Install plate electrodes in accordance with the manufacturer's instructions and **IEEE C2** and **NFPA 70**.
- c. Ground resistance - The maximum resistance of a driven ground rod must not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes, to achieve the specified ground resistance. The additional electrodes will be up to three, **8 feet** rods spaced a minimum of **10 feet** apart. 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.

3.1.2.2 Grounding Electrode Conductors

Size grounding electrode conductors as indicated. Connect secondary system neutral conductors directly to the transformer neutral bushings, then connected with a neutral bonding jumper between the transformer neutral bushing and the vertical grounding electrode conductor as indicated. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

3.1.2.3 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 must 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 must provide visible indication that a connector has been fully compressed on ground wire.

3.1.2.4 Grounding and Grounded Connections

- a. Where no primary or common neutral exists, bond surge arresters and frames of equipment operating at over 750 volts together and connected to a dedicated primary grounding electrode.
- b. Where no primary or common neutral exists, bond transformer secondary neutral bushing, secondary neutral conductor, and frames of equipment operating at under 750 volts together and connected to a dedicated secondary grounding electrode.
- c. When a primary or common neutral exists, the neutral must be connected to a grounding electrode. Transformer secondary neutral bushing and frames of equipment operating at under 750 volts must be bonded together and connected to a common neutral and to a common grounding electrode.

3.1.2.5 Protective Molding

Protect grounding conductors which are run on surface of wood poles by PVC molding extending from ground line throughout communication and transformer spaces.

3.1.3 CONDUCTOR INSTALLATION

3.1.3.1 Line Conductors

Unless otherwise indicated, install conductors in compliance with IEEE C2 Grade B requirements and in accordance with revised manufacturer's approved tables of sags and tensions. Handle conductors 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 must 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 must not be less than the applicable NEMA specification recommendation. Conductors must not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors must be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension must 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.

3.1.3.2 Connectors and Splices

Conductor splices, as installed, must exceed ultimate rated strength of conductor and must be of type recommended by conductor manufacturer. No splice must be permitted within 10 feet of a support. Connectors and splices must be mechanically and electrically secure under tension and must be of the nonbolted compression type. The tensile strength of any splice must be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors must be noncorrosive and must not adversely affect conductors. Aluminum-composition conductors must 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 must be of types recommended by the connector manufacturer. Primary line apparatus taps must be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors must be of the solderless pressure type. Noninsulated connectors must 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 must be installed above the copper.

3.1.3.3 Conductor-To-Insulator Attachments

Conductors must 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 must 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

3.1.3.4 Armor Rods

Provide armor rods for AAC, AAAC, and ACSR conductors. Armor rods must 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 must 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 must 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 must be not less than 0.05 by 0.30 inches.

For span lengths of 200 feet or more, preformed round armor rods must be used.

3.1.3.5 Ties

Provide ties on pin insulators tight against conductor and insulator and ends turned down flat against conductor so that no wire ends project.

3.1.3.6 Low-Voltage Insulated Cables

Support low-voltage cables on clevis fittings using spool insulators. Provide dead-end clevis fittings and suspensions insulators where required for adequate strength. Dead-end construction must provide a strength exceeding the rated breaking strength of the neutral messenger. Provide clevis attachments with not less than 5/8 inch through-bolts. Secondary racks may be used when installed on wood poles and where the span length does not exceed 200 feet. Secondary racks must be two-, three-, or four-wire, complete with spool insulators. Racks must meet strength and deflection requirements for heavy-duty steel racks, and must be rounded and smooth to avoid damage to conductor insulation. Each insulator must be held in place with a 5/8 inch button-head bolt equipped with a nonferrous cotter pin, or equivalent, at the bottom. Attach racks for dead-ending four No. 4/0 AWG or four larger conductors to poles with three 5/8 inch through-bolts. Attach other secondary racks to poles with at least two 5/8 inch through-bolts. Minimum vertical spacing between conductors must not be less than 8 inches.

3.1.3.7 Reinstalling Conductors

Existing conductors to be reinstalled or resagged must be strung to "final" sag table values indicated for the particular conductor type and size involved.

3.1.3.8 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.

3.1.3.9 Fittings

Dead end fittings, clamp or compression type, must conform to written recommendations of conductor manufacturer and must develop full ultimate strength of conductor.

3.1.3.10 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.

3.1.4 Risers

Secure galvanized steel conduits on poles by two hole galvanized steel pipe straps spaced as indicated and within 3 feet of any outlet or termination. Ground metallic conduits.

3.2 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting must be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 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.

3.4 FIELD QUALITY CONTROL

3.4.1 General

Perform field testing in the presence of the Contracting Officer. The Contractor must notify the Contracting Officer 10 days prior to conducting tests. The Contractor must furnish materials, labor, and equipment necessary to conduct field tests. The Contractor must perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor must 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 must 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 must replace any devices or equipment which are damaged due to improper test procedures or handling.

3.4.3 Medium-Voltage Preassembled Cable Test

After installation, prior to connection to an existing system, and before the operating test, the medium-voltage preassembled cable system must be given a high potential test. Apply direct-current voltage on each phase conductor of the system by connecting conductors at one terminal and connecting grounds or metallic shieldings or sheaths of the cable at the other terminal for each test. Prior to the test, the cables must be isolated by opening applicable protective devices and disconnecting equipment. The method, voltage, length of time, and other characteristics of the test for initial installation must be in accordance with NEMA WC 74/ICEA S-93-639 for the particular type of cable installed, and must not exceed the recommendations of IEEE 404 for cable joints unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor must make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

3.4.4 Sag and Tension Test

The Contracting Officer must 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 Pre-Energization Services

Perform the following services on the equipment listed below. Perform these services subsequent to testing but prior to the initial energization. Inspect the equipment to insure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Inspect terminations of conductors at major equipment to ensure the adequacy of connections. Inspect bare and insulated conductors between such terminations to detect possible damage during installation. If factory tests were not performed on completed assemblies, perform tests after the installation of completed assemblies. Inspect components for damage caused during installation or shipment and to ensure that packaging materials have been removed. Components capable of being both manually and electrically operated must be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested must be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services must be provided, but are not limited to, are the following:

Capacitors.

Switches.

3.4.6 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](#).

3.4.6.1 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.

3.4.7 Devices Subject to Manual Operation

Each device subject to manual operation must be operated at least three times, demonstrating satisfactory operation each time.

3.4.8 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function.

-- End of Section --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 33 71 02

UNDERGROUND ELECTRICAL DISTRIBUTION
08/21

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.

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 B3 (2013) Standard Specification for Soft or Annealed Copper Wire

ASTM B8 (2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM F512 (2019) Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 48 (2020) 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 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 C2	(2023) National Electrical Safety Code
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions
INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)	
NETA ATS	(2021) 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	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 6 & 8	(2020) Standard for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
NEMA TC 9	(2020) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation
NEMA WC 70	(2021) Power Cable Rated 2000 Volts or Less for the Distribution of Electrical Energy
NEMA WC 74/ICEA S-93-639	(2012) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(2023) 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 6	(2007; Reprint Sep 2019) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 94	(2013; Reprint Apr 2022) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint May 2021) UL Standard for Safety Wire Connectors
UL 510	(2020) 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 May 2020) Conduit, Tubing and Cable Fittings
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 854	(2020) Standard for Service-Entrance Cables
UL 1072	(2006; Reprint Apr 2020) Medium-Voltage Power Cables
UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel

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

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Std 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.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Medium Voltage Cable; G

Medium Voltage Cable Joints; G

Medium Voltage Cable Terminations; G

Live End Caps; G

SD-06 Test Reports

Medium Voltage Cable Qualification and Production Tests; G

Field Acceptance Checks and Tests; G

Arc-proofing Test for cable fireproofing tape; G

SD-07 Certificates

Cable splicer/terminator; G

Cable Installer Qualifications; G

1.5 QUALITY ASSURANCE

1.5.1 Certificate of Competency for Cable Splicer/Terminator

The cable splicer/terminator must have a certification from the National Cable Splicing Certification Board (NCSCB) in the field of splicing and terminating shielded medium voltage (5 kV to 35 kV) power cable using pre-manufactured kits (pre-molded, heat-shrink, cold shrink). Submit "Proof of Certification" for approval, for the individuals that will be performing cable splicer and termination work, 30 days before splices or terminations are to be made.

1.5.2 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.

1.5.3 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.

1.5.4 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.

1.5.4.1 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 furnished.

1.5.4.2 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 or EPC-80 as indicated.

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 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.

2.1.6 Fittings

2.1.6.1 Metal Fittings

UL 514B.

2.1.6.2 PVC Conduit Fittings

UL 514B, UL 651.

2.1.6.3 PVC Duct Fittings

NEMA TC 9.

2.1.6.4 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, or in accordance with NEMA WC 70. Wires and cables manufactured more than 24 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. All conductors must be 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](#). Copper conductors must be annealed copper complying with [ASTM B3](#) and [ASTM B8](#).

2.2.3 Jackets

Provide multiconductor cables with an overall PVC outer jacket.

2.2.4 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 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.

Color code conductors. 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. Properly identify control circuit terminations. 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 may be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems are 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

2.3 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS

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](#).

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 24 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 Type MV cable, conforming to NEMA WC 74/ICEA S-93-639 and UL 1072. Provide cables manufactured for use in duct applications as indicated. 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.

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 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.

2.5.6 Jackets

Provide cables with a PVC jacket. Provide PVC jackets with a separator

that prevents contact with underlying semiconducting insulating shield.

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. Provide terminations, where required, with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Provide terminations 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). Design termination 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. Design termination for installation in low or highly contaminated indoor or outdoor locations.

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 should 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 LIVE END CAPS

Provide live end caps using a "kit" including a heat-shrinkable tube and a high dielectric strength, polymeric plug overlapping the conductor. Conform to applicable portions of IEEE 48.

2.10 TAPE

2.10.1 Insulating Tape

UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

2.10.2 Buried Warning and Identification Tape

Provide detectable tape in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL.

2.10.3 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.

2.11 PULL ROPE

Plastic or flat pull line (bull line) having a minimum tensile strength of 200 pounds.

2.12 GROUNDING AND BONDING

2.12.1 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.

2.12.2 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.

2.13 SOURCE QUALITY CONTROL

2.13.1 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. Direct the arc 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). Test each sample assembly 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.

2.13.2 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 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.

3.4 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.4.1 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. Terminate all PVC conduit end points in utility holes, switching cabinets, transform handholes and buildings with end bells. The bell end of the conduits that enter manholes and handholes must be flush with the wall.

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 longsweep 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 allowed for use in field manufactured longsweep bend: 30 degrees.

3.4.2 Treatment

Keep ducts clean of concrete, dirt, or foreign substances during construction. Make field cuts requiring tapers with proper tools and match factory tapers. Use a coupling recommended by the duct manufacturer whenever an existing duct is connected to a duct of different material or shape. Store ducts to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Thoroughly clean ducts before being laid. Store plastic ducts on a flat surface and protected from the direct rays of the sun.

3.4.3 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.

3.4.4 Jacking and Drilling Under Roads and Structures

Conduits to be installed under existing paved areas which are not to be disturbed, and under roads and railroad tracks, must be zinc-coated, rigid steel, jacked into place. Where ducts are jacked under existing pavement, install rigid steel conduit 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. For crossings of existing railroads and airfield pavements greater than 50 feet in length, the predrilling method or the jack-and-sleeve method will be used. 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.

3.4.5 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.

3.4.6 Conduit Plugs and Pull Rope

Provide new conduit indicated as being unused or empty 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.

3.4.7 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 23 00.00 20 EXCAVATION AND FILL.

3.4.7.1 Encasement Under Roads and Structures

Under roads, paved areas, and railroad tracks, install conduits in concrete encasement of rectangular cross-section providing a minimum of 3 inch concrete cover around ducts. Extend concrete encasement 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.

3.4.8 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 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, prevent floating during concrete pouring 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 23 00.00 20 EXCAVATION AND FILL.

3.4.9 Duct Sealing

Seal all electrical penetrations for radon mitigation, maintaining integrity of the vapor barrier, and to prevent infiltration of air, insects, and vermin.

3.5 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 switches, transformers, switchgear, switchboards, and other enclosures. Cable with tape 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.

3.5.1 Cable Lubricants

Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

3.6 CONDUCTORS INSTALLED IN PARALLEL

Group conductors such that each conduit of a parallel run contains one Phase A conductor, one Phase B conductor, one Phase C conductor, and one neutral conductor.

3.7 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.

3.8 MEDIUM VOLTAGE CABLE TERMINATIONS

Make terminations in accordance with the written instruction of the termination kit manufacturer.

3.9 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.

3.9.1 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.

3.10 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.

3.11 LIVE END CAPS

Provide live end caps for single conductor medium voltage cables where indicated.

3.12 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES

Fireproof (arc proof) wire and cables which will carry current at 2200 volts or more in underground structures.

3.12.1 Fireproofing Tape

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Install tape in accordance with manufacturer's instructions.

3.12.2 Tape-Wrap

Tape-wrap metallic-sheathed or metallic armored cables without a nonmetallic protective covering over the sheath or armor prior to application of fireproofing. Wrap must be in the form of two tightly applied half-lapped layers of a pressure-sensitive 10 mil thick plastic tape, and must extend not less than one inch into the duct. Even out irregularities of the cable, such as at splices, with insulation putty before applying tape.

3.13 GROUNDING SYSTEMS

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 25 ohms.

3.13.1 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, provide an additional ground rod 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.

3.13.2 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.

3.13.3 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.

3.13.4 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.

3.14 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70 and Section 31 23 00.00 20 EXCAVATION AND FILL.

3.14.1 Reconditioning of Surfaces

3.14.1.1 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.

3.14.1.2 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.

3.15 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.15.1 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. Place slab 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.

3.15.2 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.

3.16 FIELD QUALITY CONTROL

3.16.1 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.

3.16.1.1 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)
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)

3.16.1.2 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.

3.16.1.3 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.

3.16.2 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 --

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 33 82 00

TELECOMMUNICATIONS OUTSIDE PLANT (OSP)

08/22

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 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
- 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)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

- IEEE 100 (2000; Archived) The Authoritative
Dictionary of IEEE Standards Terms
- IEEE C2 (2023) 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 ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- ANSI C62.61 (1993) American National Standard for Gas
Tube Surge Arresters on Wire Line
Telephone Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-78-B	(2020c) FOTP-78 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation
TIA-455-107	(1999a) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Set
TIA-472D000	(2007b) Fiber Optic Communications Cable for Outside Plant Use
TIA-492E000	(1996; R 2002) Sectional Specification for Class IVd Nonzero-Dispersion Single-Mode Optical Fibers for the 1550 nm Window
TIA-526-7	(2015a) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
TIA-526-14	(2015c) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2	(2018d) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	(2016d; Add 1 2019) Optical Fiber Cabling Components Standard
TIA-569	(2019e) Telecommunications Pathways and Spaces
TIA-590	(1997a) Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant
TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure
TIA-607	(2019d) 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; Add 2 2018) Optical Fiber Cable Color Coding

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 1755	Telecommunications Standards and Specifications for Materials, Equipment and Construction
RUS Bull 345-65	(1985) Shield Bonding Connectors (PE-65)
RUS Bull 345-72	(1985) Filled Splice Closures (PE-74)
RUS Bull 345-83	(1979; Rev Oct 1982) Gas Tube Surge Arrestors (PE-80)
RUS Bull 1751F-630	(1996) Design of Aerial Plant
RUS Bull 1751F-643	(2002) Underground Plant Design
RUS Bull 1751F-815	(1979) Electrical Protection of Outside Plant
RUS Bull 1753F-201	(1997) Acceptance Tests of Telecommunications Plant (PC-4)
RUS Bull 1753F-401	(1995) Splicing Copper and Fiber Optic Cables (PC-2)

UNDERWRITERS LABORATORIES (UL)

UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 497	(2001; Reprint Jul 2013) Protectors for Paired Conductor Communication Circuits
UL 510	(2020) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape

1.2 RELATED REQUIREMENTS

Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEM, Section 33 71 01, OVERHEAD TRANSMISSION AND DISTRIBUTION, 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-568.1, TIA-568.2, TIA-568.3, TIA-569, TIA-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 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. The telecommunications contractor must coordinate with the NMCI contractor concerning layout and configuration of the EF telecommunications and OSP. The telecommunications contractor may be required to coordinate work effort for access to the EF telecommunications and OSP with the NMCI contractor.

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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications Outside Plant; G

Telecommunications Entrance Facility Drawings; G

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop

drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Wire and Cable; G

Cable Splices, and Connectors; G

Closures; G

Building Protector Assemblies; G

Protector Modules; G

Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. 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 for certificates in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Pre-installation Tests; G

Acceptance Tests; G

Outside Plant Test Plan; G

SD-07 Certificates

Telecommunications Contractor Qualifications; G

Key Personnel Qualifications; G

Minimum Manufacturer's Qualifications; G

SD-08 Manufacturer's Instructions

Building Protector Assembly Installation; G

Cable Tensions; G

Fiber Optic Splices; G

Submit instructions prior to installation.

SD-09 Manufacturer's Field Reports

Factory Reel Test Data; G

SD-10 Operation and Maintenance Data

Telecommunications Outside Plant (OSP), Data Package 5; G

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

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 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-568.1](#), [TIA-568.2](#) and [TIA-568.3](#). 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 conductor and 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-568.1](#) 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. All products must be approved by BCO/TSD via CO.

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 BCO/TSD via 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 500 feet 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 and must be approved by BCO/TSD.

2.2 TELECOMMUNICATIONS ENTRANCE FACILITY

2.2.1 Building Protector Assemblies

Provide self-contained 5 pin unit supplied with a field cable stub factory connected to protector socket blocks to terminate and accept protector modules for pairs of outside cable. Building protector assembly shall have interconnecting hardware for connection to interior cabling at full capacity. Provide manufacturers instructions for building protector assembly installation. Provide copper cable interconnecting hardware as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM. Coordinate multiple protectors with BCO.

2.2.2 Protector Modules

Provide in accordance with UL 497 three-electrode gas tube or solid state type 5 pin rated for the application. Provide gas tube protection modules in accordance with RUS Bull 345-83 and shall be heavy duty, A>10kA, B>400, C>65A where A is the maximum single impulse discharge current, B is the impulse life and C is the AC discharge current in accordance with ANSI C62.61. The gas modules shall shunt high voltage to ground, fail short, and be equipped with an external spark gap and heat coils in accordance with UL 497. Provide the number of surge protection modules equal to the number of pairs of exterior cable of the building protector assembly.

2.2.3 Fiber Optic Terminations

Provide fiber optic cable terminations as specified in 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.3 CLOSURES

2.3.1 Copper Conductor Closures

2.3.1.1 Underground Cable Closures

- a. Aboveground: Provide aboveground closures constructed of not less than 14 gauge steel and acceptable for pole mounting in accordance with RUS 1755.910. Closures shall be sized and contain a marker as indicated. Covers shall be secured to prevent unauthorized entry.
- b. Direct burial: Provide buried closure suitable for enclosing a straight, butt, and branch splice in a container into which can be poured an encapsulating compound. Closure shall have adequate strength to protect the splice and maintain cable shield electrical continuity in the buried environment. Encapsulating compound shall be reenterable and shall not alter the chemical stability of the closure. Provide filled splice cases in accordance with RUS Bull 345-72. Note: Camp Lejeune does not use buried closures.
- c. In vault or manhole: Provide underground closure suitable to house a straight, butt, and branch splice in a protective housing into which can be poured an encapsulating compound. Closure shall be of suitable 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. Provide filled splice cases in accordance with RUS Bull 345-72. Closure shall only be flash tested and encapsulate provided.

2.3.2 Fiber Optic Closures

2.3.2.1 Aerial

Provide aerial closure that is free breathing and suitable for housing splice organizer of non -pressurized cables. Closure shall be constructed from heavy PVC with ultraviolet resistance. Note: Camp Lejeune does not have Aerial.

2.3.2.2 Direct Burial

Provide buried closure suitable to house splice organizer in protective housing into which can be poured an encapsulating compound. Closure shall have adequate strength to protect the splice and maintain cable shield electrical continuity, when metallic, in buried environment. Encapsulating compound shall be reenterable and shall not alter chemical stability of the closure. Note: Camp Lejeune does not use buried closures.

2.3.2.3 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. Closure should only be flash tested and encapsulate provided.

2.4 CABLE SPLICES, AND CONNECTORS

2.4.1 Copper Cable Splices

Provide multipair, foldback splices of a moisture resistant, two-wire insulation displacement connector held rigidly in place to assure maximum continuity in accordance with [RUS Bull 1753F-401](#). Cables greater than 25 pairs shall be spliced using multipair splicing connectors, which accommodate 25 pairs of conductors at a time. Provide correct connector size to accommodate the cable gauge of the supplied cable.

2.4.2 Copper Cable Splice Connector

Provide splice connectors with a polycarbonate body and cap and a tin-plated brass contact element. Connector shall accommodate 22 to 26 AWG solid wire with a maximum insulation diameter of [0.065 inch](#). Fill connector with sealant grease to make a moisture resistant connection, in accordance with [RUS Bull 1753F-401](#).

2.4.3 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.

2.4.4 Shield Connectors

Provide connectors with a stable, low-impedance electrical connection between the cable shield and the bonding conductor in accordance with [RUS Bull 345-65](#).

2.5 CONDUIT

Provide conduit as specified in Section [33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION](#), [BICSI OSP Design](#), and guidance from [BCO/TSD via Contracting Officer](#).

2.6 PLASTIC INSULATING TAPE

[UL 510](#). Tape shall be premium quality, heavy-duty, weather resistant.

2.7 WIRE AND CABLE

2.7.1 Copper Conductor Cable

Solid copper conductors, covered with an extruded solid insulating compound. Insulated conductors shall be twisted into pairs which are then stranded or oscillated to form a cylindrical core. For special high frequency applications, the cable core shall be separated into compartments. Cable shall be completed by the application of a suitable core wrapping material, a corrugated copper or plastic coated aluminum shield, and an overall extruded jacket. Telecommunications contractor shall verify distances between splice points prior to ordering cable in specific cut lengths. Gauge of conductor shall determine the range of

numbers of pairs specified; 19 gauge (6 to 400 pairs), 22 gauge (6 to 1200 pairs), 24 gauge (6 to 2100 pairs), and 26 gauge (6 to 3000 pairs). PE-39 shall be used whenever available. PE-89 is only authorized when PE-39 is not available. Copper conductor shall conform to the following:

2.7.1.1 Underground

Provide filled cable meeting the requirements of ICEA S-99-689 and RUS 1755.390 (type PE-39/89). Provide enough slack for splicing.

2.7.1.2 Screen

Provide screen-compartmental core cable filled cable meeting the requirements of ICEA S-99-689 and RUS 1755.390.

2.7.2 Fiber Optic Cable

Provide single-mode, 8/125-um, 0.10 aperture 1550 nm fiber optic cable in accordance with TIA-492E000, 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 shielded and specifically designed for outside use with loose buffer construction. Provide fiber optic color code in accordance with TIA/EIA-598

2.7.2.1 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.

2.7.2.2 Shielding or Other Metallic Covering

Provide copper, copper alloy or copper and steel laminate, single tape covering or shield in accordance with ICEA S-87-640. Over all shield is for locating.

2.7.2.3 Performance Requirements

Provide fiber optic cable with optical and mechanical performance requirements in accordance with ICEA S-87-640.

2.7.3 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 stainless steel and labeled in accordance with TIA-606. Handwritten labeling is unacceptable. Coordinate cable tag information with TSD.

2.8.1 Stainless Steel

Provide stainless steel, cable tags 1 5/8 inches in diameter 1/16 inch thick minimum, and circular in shape. Tags shall be die stamped with numbers, letters, and symbols not less than 0.25 inch high and approximately 0.015 inch deep in normal block style.

2.9 BURIED WARNING AND IDENTIFICATION TAPE

Provide fiber optic media marking and protection in accordance with TIA-590. Provide color, type and depth of tape as specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 23 00.00 20, EXCAVATION AND FILL.

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-568.1 and TIA-568.3. 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 BCO/TSD vis 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/ BCO/TSD. 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, existing ducts as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION with any additional requirements as specified herein. Ducts shall be min 103mm 4 inch and 4way.

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 BCO/TSD aluminum test mandrel, after contractor removal of foreign material and 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 / BCO/TSD. 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. Mandrel should glide through and be hand pulled (BICSI).

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.
Provide adequate slack for splicing operations.

3.1.8 Cable Splicing

3.1.8.1 Copper Conductor Splices

Perform splicing in accordance with requirements of RUS Bull 1753F-401 except that direct buried splices and twisted and soldered splices are not allowed. Exception does not apply for pairs assigned for carrier or CATV application.

3.1.8.2 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 Surge Protection

All cables and conductors, except fiber optic cable, which serve as communication lines through off-premise lines, shall have surge protection installed at each end which meet the requirements of RUS Bull 1751F-815.

3.1.10 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.

3.1.10.1 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. Establish a TMGB for connection point for cable stub shields to connector blocks and CD protector assemblies as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.10.2 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.

3.1.10.3 Campus Distributor Grounding

- a. Protection assemblies: Mount CD protector assemblies directly on the telecommunications backboard. Connect assemblies mounted on each vertical frame with No. 6 AWG copper conductor to provide a low resistance path to TMGB.
- b. TMGB connection: Connect TMGB to TGB with copper conductor with a total resistance of less than 0.01 ohms.

3.1.11 Cut-Over

All necessary transfers and cut-overs, shall be coordinated with BCO/TSD as some may/may not be accomplished by the telecommunications contractor.

3.2 LABELING

3.2.1 Labels

Provide labeling for new cabling and termination hardware located within the facility in accordance with TIA-606. 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 new wire and cable provided under this contract and existing wire and cable which are indicated to have splices and terminations provided by this contract. The labeling of telecommunications cable tag identifiers shall be in accordance with TIA-606. 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 TIA-606.

3.3 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.

3.4 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.

3.4.1 Pre-Installation Tests

Perform the following 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.

3.4.1.1 Cable Capacitance

Perform capacitance tests on at least 10 percent of the pairs within a cable to determine if cable capacitance is within the limits specified.

3.4.1.2 Loop Resistance

Perform DC-loop resistance on at least 10 percent of the pairs within a cable to determine if DC-loop resistance is within the manufacturer's

calculated resistance.

3.4.1.3 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.

3.4.2 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 **local provider format** showing all field tests performed, upon completion and testing of the installed system, **to the Contracting Officer /BCO /TSD**. Measurements shall be tabulated on a pair by pair or strand by strand basis.

3.4.2.1 Copper Conductor Cable

Perform the following acceptance tests in accordance with **TIA-758**:

- a. Wire map (pin to pin continuity)
- b. Continuity to remote end
- c. Crossed pairs
- d. Reversed pairs
- e. Split pairs
- f. Shorts between two or more conductors

3.4.2.2 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

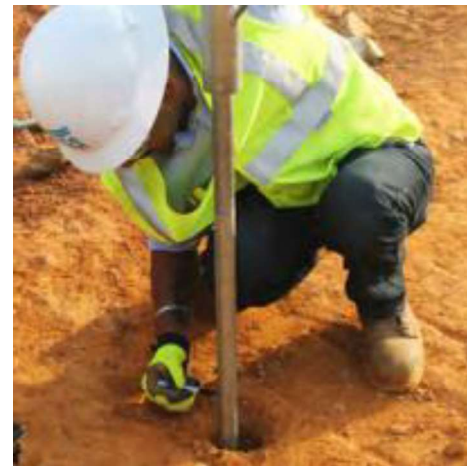
the OTDR for each fiber in each span and shall be included in the test results. The OTDR test shall be measured in both directions. A reference length of fiber, 66 feet minimum, used as the delay line shall be placed before the new end connector and after the far end patch panel connectors for inspection 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 1550 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 and 1550 nm for single-mode fiber. Attenuation losses shall not exceed 5.0 db/km at 850 nm and 1.5 db/km at 1300 nm for multimode 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.

3.4.3 Soil Density Tests

- a. Determine soil-density relationships for compaction of backfill material in accordance with ASTM D1557, Method D.

-- End of Section --



ECS Southeast, LLP

Geotechnical Engineering Report

P1594 RR1 Replacement

Stone Bay, Onslow County, North Carolina

ECS Project Number 22:32370

January 24, 2023





January 24, 2023

Mr. Raymond Layton
MBF Architects, PA
317-C Pollock Street
New Bern, North Carolina 28560

ECS Project No. 22:32370

Reference: Geotechnical Engineering Report
P1594 RR1 Replacement
Stone Bay, Onslow County, North Carolina

Dear Mr. Layton:

ECS Southeast (ECS) has completed the subsurface exploration and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with our Proposal No. 22:26560, dated August 3, 2022. This report presents our understanding of the geotechnical aspects of the project along with, the results of the field exploration, and our design and construction recommendations.

It has been our pleasure to be of service to MBF Architects, PA during the design phase of this project. We would appreciate the opportunity to remain involved during the continuation of the design phase, and we would like to provide our services during construction phase operations to verify the assumptions of subsurface conditions made for this report. Should you have any questions concerning the information contained in this report, and when we can be of further assistance to you, please contact us.

Respectfully submitted,

ECS Southeast, LLP

Annemarie Crumrine, P.E.
Geotechnical Department Manager
ACrumrine@ecslimited.com

Winslow Goins, P.E.
Principal Engineer
WGoins@ecslimited.com



TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
1.0 INTRODUCTION	2
1.1 General	2
2.0 PROJECT INFORMATION	3
2.1 Project Location.....	3
2.2 Current Site Conditions	3
2.3 Historical Information	4
2.4 Proposed Construction.....	4
3.0 FIELD EXPLORATION	5
3.1 Subsurface characterization	5
3.2 Groundwater and Seasonal High Water Table Observations	5
3.3 Laboratory Testing	6
4.0 DESIGN RECOMMENDATIONS	7
4.1 Shallow Foundations	7
4.2 Slabs On Grade	8
4.3 Seismic Design Considerations.....	9
4.4 Pavements.....	10
4.5 Lateral Earth Pressure and Soil Parameters	12
5.0 SITE CONSTRUCTION RECOMMENDATIONS	13
5.1 Subgrade Preparation	13
5.1.1 Stripping and Grubbing.....	13
5.1.2 Proofrolling	13
5.2 Earthwork Operations	13
5.2.1 Existing Man-Placed Fill	13
5.2.2 Structural Fill.....	14
5.3 Foundation and Slab Observations	15
5.4 Utility Installations	15
6.0 CLOSING.....	17

APPENDICES

Appendix A – Drawings

- Site Vicinity Map (USGS 7.5-Minute Quadrangle Topographic Map)
- Site Location Diagram (Aerial Map)
- Boring Location Diagram (Topographic Map)
- Boring Location Diagram

Appendix B – Field Operations

- Reference Notes for Boring Logs
- SPT Boring Logs (B-1 and B-2)
- Subsurface Soil Profile
- Reference Notes for CPT Soundings
- Cone Penetration Test Sounding Logs (S-1 and S-2)
- Dissipation Test Results (S-1 and S-2)
- Hand Auger Boring Logs (C-1 through C-3)
- Kessler DCP Test Data (C-1 through C-3)
- Photos of Cores (C-1 through C-3)

Appendix C – Laboratory Testing

- Laboratory Test Results Summary
- Atterberg Limit Tests
- Grain Size Analyses Results

Appendix D – Historical Information

- Historical Aerial Imagery
- Historical Topographic Maps

Appendix E – Supplemental Report Documents

- GBA Document

EXECUTIVE SUMMARY

The following summarizes the main findings of the exploration, particularly those that may have a cost impact on the planned development. Further, our principal foundation recommendations are summarized. Information gleaned from the executive summary should not be utilized in lieu of reading the entire geotechnical data report.

- The geotechnical exploration performed for the site included two (2) electronic cone penetration test (CPT) soundings drilled to termination and refusal depths of approximately 56 to 66 feet in the area of the proposed buildings, two (2) standard penetration test (SPT) borings drilled to termination depths of 65 feet in the area of the proposed buildings. Three (3) asphalt cores and Kessler dynamic cone penetrometer (DCP) tests with hand auger borings were performed in the existing pavements.
- Provided the subgrades are prepared as recommended in this report and the column and wall loads do not exceed the anticipated column and wall loads provided in the table in **Section 2.4**, the planned structures may be supported by conventional shallow foundations consisting of column or strip footings bearing on compacted structural fill and natural soils using a net allowable soil bearing pressure of 2,500 psf.
- Groundwater was encountered in our soundings and borings at depths ranging from approximately 5.1 to 7.66 feet below existing grades at the time of drilling. Seasonal high water table was encountered in hand auger borings at depths ranging from approximately 3.2 feet to 4.5 feet below existing grade.

Please note this Executive Summary is an important part of this report and should be considered a **“summary”** only. The subsequent sections of this report constitute our findings, conclusions, and recommendations in their entirety.

1.0 INTRODUCTION

1.1 GENERAL

The purpose of this study was to provide geotechnical information for the proposed reconstruction of the Rifle Range Building 1 located off of Rifle Range Road at Stone Bay in Sneads Ferry, Onslow County, North Carolina. The recommendations developed for this report are based on project information supplied by NAVFAC and MBF Architects, PA.

Our Services were provided in accordance with our Proposal No. 22:26560, dated August 3, 2022, as authorized by Mr. William Faulkenberry of MBF Architects, PA.

This report contains the procedures and results of our subsurface exploration programs, review of existing site conditions, engineering analyses, and recommendations for the design and construction of the project.

The report includes the following items.

- A brief review and description of our field test procedures and the results of testing conducted;
- A review of surface topographical features and site conditions;
- A review of subsurface soil stratigraphy with pertinent available physical properties;
- Foundation recommendations;
 - Allowable bearing pressure;
 - Settlement estimates (total and differential);
- Site development recommendations;
- Reusability of soils for use as fill material;
- Pavement design recommendations;
- Seismic site class and liquefaction recommendations;
- In-situ soil parameters;
- Discussion of groundwater impact;
- Compaction recommendations;
- Site vicinity map;
- Exploration location plan;
- Laboratory test results;
- Seasonal High Water Table testing results;
- CPT sounding logs; and
- SPT boring logs.

2.0 PROJECT INFORMATION

2.1 PROJECT LOCATION

The site is located in the historic district off of Rifle Range Road at Stone Bay in Sneads Ferry, Onslow County, North Carolina. The site is bounded on the west and north by Powder Lane, on the east by Rifle Range Road, and on the south by existing buildings. Figure 2.1.1 below shows an aerial image of the site.



Figure 2.1.1 Site Location

2.2 CURRENT SITE CONDITIONS

At the time of our exploration, the previous Rifle Range Building 1 had been demolished. The site consisted of the existing parking lot and contained debris piles in the vicinity of the proposed building from the demolition at the time of our exploration. Based on our site visit, provided plans, and approximate elevations taken from Google Earth, the site is relatively level, with typical site elevations ranging from approximately 48 to 50.5 feet.

2.3 HISTORICAL INFORMATION

Based on a review of available historic aerial imagery dating back to March 1993, the site appears to be relatively the same development from 1993 to 2019 with the exclusion of the parking lot being paved. Based on the aerial imagery the existing parking lot appears to have gone from an unpaved lot to a paved parking lot between December 2011 and April 2014. The site previously consisted of the Rifle Range building 1 dating back prior to 1993 that was demolished prior to our exploration. See the available aerial imagery referenced in Appendix E of this report.

Based on a review of available historic topographic maps dating back to 1952, there have been no apparent significant grade changes on the site. See the available historic topographic maps referenced in Appendix E of this report.

2.4 PROPOSED CONSTRUCTION

The following information explains our understanding of the planned development including proposed building and related infrastructure:

SUBJECT	DESIGN INFORMATION / ASSUMPTIONS
Usage	Rifle Range Building 1 (RR1)
Column Loads	Up to 160 kips
Wall Loads	Up to 6 klf
Finish Floor Elevation (FFE)	51.32 feet
Bottom of Footing Below FFE	-3.67 to -5.0 feet

ECS understands the project consists of reconstructing a new two-story H-style building within the original building footprint. ECS understands the proposed RR1 building is approximately 27,093 square foot H-style building with a slab on grade. The project also is proposed to include replacing existing sidewalks and resurfacing the existing parking lot to the west of the proposed RR1 building.

3.0 FIELD EXPLORATION

Our exploration procedures are explained in greater detail in Appendix B including the Reference Notes for Standard Penetration Testing and Reference Notes for Cone Penetration Soundings. Our scope of work included performing two (2) SPT borings and two (2) CPT soundings, and three (3) asphalt cores and Kessler dynamic cone penetrometer (DCP) tests with hand auger borings. Our approximate SPT boring, CPT sounding, and hand auger boring locations are shown on the Exploration Location Diagram in Appendix A.

3.1 SUBSURFACE CHARACTERIZATION

The subsurface conditions encountered were generally consistent with the published geological mapping. The following sections provide generalized characterizations of the soil. The generalized subsurface stratigraphy encountered on site is shown below in Table 3.1.1. Please refer to the SPT boring logs, CPT sounding logs, and hand auger boring logs in Appendix B.

The site is located in the Coastal Plain Physiographic Province of North Carolina. The Coastal Plain is composed of seven terraces, each representing a former level of the Atlantic Ocean. Soils in this area generally consist of sedimentary materials transported from other areas by the ocean or rivers. These deposits vary in thickness from a thin veneer along the western edge of the region to more than 10,000 feet near the coast. The sedimentary deposits of the Coastal Plain rest upon consolidated rocks similar to those underlying the Piedmont and Mountain Physiographic Provinces. In general, shallow unconfined groundwater movement within the overlying soils is largely controlled by topographic gradients. Recharge occurs primarily by infiltration along higher elevations and typically discharges into streams or other surface water bodies. The elevation of the shallow water table is transient and can vary greatly with seasonal fluctuations in precipitation.

Table 3.1.1 Subsurface Stratigraphy

Approximate Depth Range (feet)	Stratum	Description	Ranges of CPT N*-Values ⁽¹⁾ blows per foot (bpf)	Ranges of SPT N-Values ⁽²⁾ blows per foot (bpf)
0 to 12	I	Very Loose to Dense, SILTY, Slightly SILTY and CLEAN SAND (SM, SP-SM, SP), moist to saturated.	1 to 35	1 to 15
12 to 22	II	Very Loose to Medium Dense, SILTY and CLEAN SAND (SM, SP) with interbedded layers of Soft to Stiff, SANDY SILT (ML) and SILTY and SANDY LEAN CLAY (CL-ML, CL), saturated.	2 to 19	2 to 12
22 to 45	III	Very Soft to Firm, SANDY SILT (ML) and SANDY LEAN CLAY (CL), saturated.	3 to 6	Weight of Hammer (W.O.H.) to 1
45 to 65	IV	Medium Dense to Very Dense, SILTY SANDS (SM) and Stiff to Very Hard, SANDY SILT (ML) and SANDY LEAN CLAY (CL), saturated.	10 to in excess of 100	14 to 43

Notes: (1) Equivalent Corrected Standard Penetration Test Resistances (CPT Soundings)
(2) Standard Penetration Test Resistances (SPT Borings)

3.2 GROUNDWATER AND SEASONAL HIGH WATER TABLE OBSERVATIONS

Water levels were encountered in our CPT soundings and SPT borings and are shown in Appendix B. Groundwater depths at the time of drilling range from approximately 5.1 to 7.66 feet below the ground surface. Variations in the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, construction activities, and other factors. The seasonal high water table (SHWT) was encountered in the hand auger borings on site at approximately 3.2 feet to 4.5 feet below the existing grades at the time of exploration.

Boring/Sounding	Seasonal High Water Table (SHWT)
B-1	50 inches
B-2	54 inches
S-1	40 inches
S-2	38 inches

3.3 LABORATORY TESTING

The laboratory testing consisted of selected tests performed on samples obtained during our field exploration operations. Classification and index property tests were performed on representative soil samples.

Each sample was visually classified on the basis of texture and plasticity in accordance with ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures) and including USCS classification symbols, and ASTM D2487 Standard Practice for Classification for Engineering Purposes (Unified Soil Classification System, USCS). After classification, the samples were grouped in the major zones noted on the boring logs in Appendix B. The group symbols for each soil type are indicated in parentheses along with the soil descriptions. The stratification lines between strata on the logs are approximate; in situ, the transitions may be gradual.

The laboratory testing program was designed to evaluate the index properties of the soil at the site. Samples were tested to measure moisture content, Atterberg limits, and grain size sieve analysis results where appropriate.

Results of the laboratory testing are included in Appendix C.

4.0 DESIGN RECOMMENDATIONS

4.1 SHALLOW FOUNDATIONS

Provided subgrades and structural fills are prepared as recommended in this report and the anticipated column and wall loads in **Section 2.4** are not exceeded, the proposed structure can be supported by shallow foundations including column footings and continuous wall footings. We recommend the foundation design use the following parameters:

Design Parameter	Column Footing	Wall Footing
Net Allowable Bearing Pressure ⁽¹⁾	2,500 psf	2,500 psf
Recommended Bearing Soil Material	Stratum I Soils or Structural Fill	Stratum I Soils or Structural Fill
Minimum Width	30 inches	18 inches
Minimum Footing Embedment Depth (below slab or finished grade) ⁽²⁾	12 inches	12 inches
Minimum Exterior Frost Depth (below final exterior grade)	6 inches	6 inches
Estimated Total Settlement ⁽³⁾	Less than 1- inch	Less than 1- inch
Estimated Differential Settlement ⁽⁴⁾	Less than ½ inches between columns	Less than ½ inches

Notes:

- (1) Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.
- (2) For bearing considerations and frost penetration requirements.
- (3) Based on assumed structural loads. If final loads are different, ECS must be contacted to update foundation recommendations and settlement calculations.
- (4) Based on maximum column/wall loads and variability in borings. Differential settlement can be re-evaluated once the foundation plans are finished.

Potential Undercuts: A majority of the soils at the estimated foundation bearing elevation are anticipated to be adequate for support of the proposed structures. If soft or loose soils are observed at the footing bearing elevations, the soils should be undercut and removed. Undercut should be backfilled with structural fill up to the original design bottom of footing elevation; the original footing may be constructed on top of the structural fill.

4.2 SLABS ON GRADE

The on-site natural soils are generally considered suitable for support of the lowest floor slabs. Based on the assumption that the finished floor elevation is around 51.32 feet, it appears that the slabs for the structure will likely bear on the Stratum I soils SAND (SM, SP-SM, SP) or approved structural fill. The following graphic depicts our soil-supported slab recommendations:

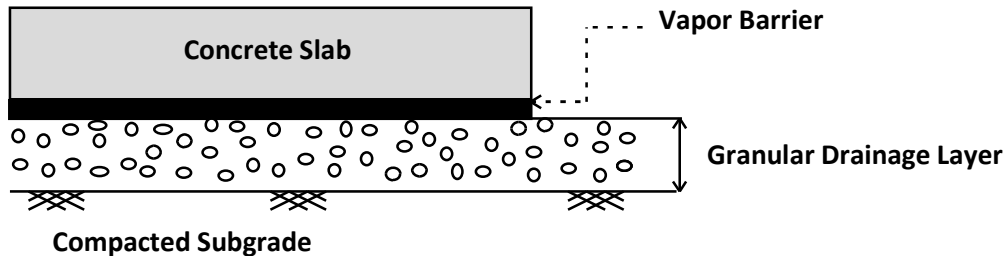


Figure 4.2.1

1. Drainage Layer Thickness: 6 inches
2. Drainage Layer Material: GRAVEL (GP) or SAND containing <5% fines passing #200 sieve (SP, SW)

Soft or yielding soils may be encountered in some areas. Those soils should be removed and replaced with compacted Structural Fill in accordance with the recommendations included in this report.

Subgrade Modulus: Provided the Structural Fill and Granular Drainage Layer are constructed in accordance with our recommendations, the slab may be designed assuming a modulus of subgrade reaction, k_1 of 150 pci (lbs./cu. inch). The modulus of subgrade reaction value is based on a 1 ft by 1 ft plate load test basis.

Vapor Barrier: Before the placement of concrete, a vapor barrier may be placed on top of the granular drainage layer to provide additional protection against moisture vapor penetration through the floor slab. Curing of the slab should be performed in accordance with ACI specifications to reduce the potential for uneven drying, curling and/or cracking of the slab. Depending on proposed flooring material types, the structural engineer and/or the architect may choose to do away with the vapor barrier.

Slab Isolation: Soil-supported slabs should be isolated from the foundations and foundation-supported elements of the structure so that differential movement between the foundations and slab will not induce excessive shear and bending stresses in the floor slab. Where the structural configuration inhibits the use of a free-floating slab such as in a drop down footing/monolithic slab configuration, the slab should be designed to avoid overstressing of the slab.

Passive Air Vapor Intrusion Mitigation System: A passive air vapor system consisting of spray applied membrane and passive venting should be installed in accordance with the NAVFAC "Vapor Intrusion Mitigation in Construction of New Buildings Fact Sheet" and per US EPA Guidelines by an experienced design/build contractor.

4.3 SEISMIC DESIGN CONSIDERATIONS

Seismic Site Classification: The ASCE 7-16, requires site classification for seismic design based on the upper 100 feet of a soil profile. Three methods are utilized in classifying sites, namely the shear wave velocity (v_s) method; the unconfined compressive strength (s_u) method; and the Standard Penetration Resistance (N-value) method. The shear wave velocity method was used in classifying this site.

Based upon our interpretation of the subsurface conditions, the appropriate Seismic Site Classification is “D.”

Liquefaction: When a saturated soil with little to no cohesion liquefies during a major earthquake, it experiences a temporary loss of shear strength as a result of a transient rise in excess pore water pressure generated by strong ground motion. Flow failure, lateral spreading, differential settlement, loss of bearing, ground fissures, and sand boils are evidence of excess pore pressure generation and liquefaction.

The potential for liquefaction at the site is considered low based upon the CPT results and the liquefaction index procedure developed by Iwasaki (1982). Based on our CPT results and our evaluation using a site peak ground acceleration of 0.09 (PGA_m) per ASCE7-16, an earthquake event with a magnitude of 7.3 and procedures developed by Robertson (2009) and Boulanger and Idriss (2014), the liquefaction induced settlement at the subject site is estimated to be approximately 0.1 inches or less.

Ground Motion Parameters: ECS has determined the design spectral response acceleration parameters following the ASCE7-16 methodology. The mapped responses were estimated from the free ATC Hazards by Location Tool available from the USGS website (<https://hazards.atcouncil.org>). The design responses for the short (0.2 sec, S_{DS}) and 1-second period (S_{D1}) are noted in bold at the far right end of the following table.

GROUND MOTION PARAMETERS – SITE CLASS D [ASCE7-16 Method]									
Period (sec)	Mapped Spectral Response Accelerations (g)		Values of Site Coefficient for Site Class		Maximum Spectral Response Acceleration Adjusted for Site Class (g)		Design Spectral Response Acceleration (g)		
Reference	Figures 1613.3.1 (1) & (2)		Tables 1613.3.3 (1) & (2)		Eqs. 16-37 & 16-38		Eqs. 16-39 & 16-40		
0.2	S_s	0.118	F_a	1.6	$S_{MS}=F_a S_s$	0.188	$S_{DS}=2/3 S_{MS}$	0.126	
1.0	S_1	0.056	F_v	2.4	$S_{M1}=F_v S_1$	0.135	$S_{D1}=2/3 S_{M1}$	0.090	

The Site Class definition should not be confused with the Seismic Design Category designation which the Structural Engineer typically assesses.

4.4 PAVEMENTS

Existing Pavement Condition: The cores performed in the existing parking lot encountered approximately 3.5 to 6.0 inches of asphalt overlying approximately 8.0 to 14.0 inches of aggregate base. The results of the existing pavement cores are shown in the following table:

EXISTING PAVEMENT CONDITIONS		
Boring Location	Asphalt Thickness [Inches]	ABC Stone Thickness [Inches]
C-1	3.5	14.0
C-2	4.0	9.0
C-3	6.0	8.0

Subgrade Characteristics: Based on the results of our hand auger borings, it appears that the pavement subgrades will consist mainly of SILTY and CLEAN SAND (SM, SP).

California Bearing Ratio (CBR) values were obtained from the Kessler DCP tests performed at the asphalt core and hand auger boring locations. For preliminary design purposes, provided subgrade preparation are followed, we recommend assuming a preliminary CBR value of 8.

ECS understands that the existing parking lot is proposed to be milled and resurfaced. The existing ABC stone at the site can be re-used.

We were not provided traffic loading information so we have assumed loadings typical of this type of project. Our recommended pavement sections are based on up to 30,000 ESALs over a 20 year design life for light duty and up to 200,000 ESALs over a 20 year design life for heavy duty. A design base course CBR of 80 was used for this design. The preliminary pavement sections below are guidelines that comply with the UFC-3-250-01FA minimum thicknesses.

PROPOSED PAVEMENT SECTIONS		
MATERIAL	FLEXIBLE PAVEMENT	
	Heavy Duty	Light Duty
Asphalt Surface Course	1 in.	2 in.
Asphalt Intermediate Course	2.5 in.	-
Graded Aggregate Base Course	8 in.	8 in.

In general, heavy duty sections are areas that will be subjected to trucks, buses, ambulances, or other similar vehicles including main drive lanes of the development. Light duty sections are appropriate for vehicular traffic and parking areas.

Large, front loading trash dumpsters frequently impose concentrated front wheel loads on pavements during loading. This type of loading typically results in rutting of asphalt pavement and ultimately pavement failures. For preliminary design purposes, we recommend that the pavement in trash pickup areas consist of a 6-inch thick, 4,500 psi, reinforced concrete slab overlying 4 inches of ABC stone. When traffic loading becomes available, ECS or the Civil Engineer can design the pavements.

Prior to subbase placement and paving, CBR testing of the subgrade soils (both natural and fill soils) should be performed to determine the soil engineering properties for final pavement design. A minimum distance of 18 inches should be maintained between the bottom of the pavement section and the groundwater table.

The soil subgrade should be smooth-rolled and proofrolled prior to ABC placement. Areas that pump, rut, or are otherwise unstable should be re-compacted or undercut and replaced. The ABC should conform to the gradation, liquid limit, plasticity index, resistance to abrasion, and soundness per Section 1005 of the 2012 NCDOT Standard Specifications for Roads and Structures.

The ABC should be placed and be compacted in accordance with Section 520 of the 2012 NCDOT Standard Specifications for Roads and Structures. The ABC should be placed in a single lift. It should be spread after end-dumping on previously-placed ABC to deter rutting and degradation of the relatively clean sand subgrade soils by rubber-tired dump trucks. The ABC should be compacted to at least 98 percent of its Modified Proctor maximum dry unit weight per ASTM D1557 or AASHTO T180 (as modified by NCDOT), provided nuclear density testing is performed. Otherwise, at least 100 percent compaction is recommended.

The Portland cement concrete pavement section should consist of air-entrained Portland cement concrete having a minimum 28-day compressive strength of 4,500 psi. The rigid pavement section should be provided with construction joints and saw-cut control joints at appropriate intervals per Portland Cement Association (PCA) requirements. The construction joints should be reinforced with dowels to transfer loads across the joints. Wire mesh should be included to control shrinkage cracking of the concrete.

To confirm that the specified degree of compaction is being obtained, field compaction testing should be performed in each ABC lift by ECS' representative. We recommend that compaction tests be performed at a minimum frequency of one test per 5,000 square feet per lift in pavement areas.

Minimum Material Lift Thickness: The minimum lift thickness for asphalt surface course mix S9.5B is 1.0 inch and the maximum lift thickness for S9.5B is 1.5 inches. For sections with more than 1.5 inches of S9.5B surface asphalt, it should be placed in two lifts. Asphalt pavement S9.5B should be compacted to least 90.0 percent of the material's specific gravity G_{mm} .

Drainage: An important consideration with the design and construction of pavements is surface and subsurface drainage. Where standing water develops, either on the pavement surface or within the aggregate base course layer, softening of the subgrades and other problems related to the deterioration of the pavement can be expected. This is particularly important at the site due to the moisture sensitive near-surface soils. Furthermore, good drainage should help reduce the possibility of the subgrade materials becoming saturated during the normal service period of the pavement.

4.5 LATERAL EARTH PRESSURE AND SOIL PARAMETERS

Below-grade structures utilized for this project should be designed to withstand the lateral earth pressures and hydrostatic forces exerted upon them. In the design of the walls to restrain compacted engineered fill or in-situ natural soils, the soil parameters that can be utilized for the walls during the construction are summarized in the following tables:

Table 4.4.1 Soil Parameters

Depth Range ⁽¹⁾ (ft)	Coefficient of Active Earth Pressure, K_a	Coefficient of Passive Earth Pressure, K_p	Coefficient of At-Rest Earth Pressure, K_0	Friction Angle	Cohesion (psf)	Total and Effective Unit Weight (pcf)
0.0 to 4.0	0.31	3.25	0.47	32	0	115 (52.6)
4.0 to 8.0	0.26	3.85	0.41	36	0	120 (57.6)
8.0 to 12.0	0.31	3.25	0.47	32	0	115 (52.6)
12.0 to 22.0	0.38	2.66	0.55	27	200	110 (47.6)
22.0 to 47.0	0.39	2.56	0.56	26	100	105 (42.6)
47.0 to 65.0	0.24	4.20	0.38	38	1500	130 (67.6)

Notes: (1) Depths are based on approximate depth below existing grade at the time of the borings.

These recommendations have assumed no surcharge loads. The increased lateral pressures generated by surcharge loads (i.e. slopes, parking and building areas, etc.) should be considered in the design. The wall should be designed to resist hydrostatic pressures.

For wall conditions where wall movement cannot be tolerated or where the wall is restrained at the top, the "At Rest" earth pressure should be used. For wall conditions where outward wall movement in the range of 0.5 to 1 percent of the wall height can be tolerated, the "Active" earth pressure should be used. In evaluating the resistance of soil to lateral loads imposed by structures, the "Passive" earth pressure should be used. Please note that the full development of passive pressure requires deflections toward the soil mass on the order of 1 to 4 percent of the wall height.

5.0 SITE CONSTRUCTION RECOMMENDATIONS

5.1 SUBGRADE PREPARATION

5.1.1 Stripping and Grubbing

The subgrade preparation should consist of stripping vegetation, rootmat, topsoil, existing fill, and any soft or unsuitable materials from the 10-foot expanded building and 5-foot expanded pavement limits. Borings and soundings performed in the vicinity of the demolished building observed debris in the near surface soils to depths of approximately up to 1.5 to 2 feet. ECS should be retained to verify that surficial organic soil, topsoil, debris, and unsuitable surficial materials have been removed prior to the placement of structural fill or construction of structures.

5.1.2 Proofrolling

Prior to fill placement or other construction on subgrades, the subgrades should be evaluated by an ECS field technician. The exposed subgrade should be thoroughly proofrolled with construction equipment having a minimum axle load of 10 tons [e.g., fully loaded tandem-axle dump truck]. Proofrolling should be traversed in two perpendicular directions with overlapping passes of the vehicle under the observation of an ECS technician. This procedure is intended to assist in identifying any localized yielding materials.

Where proofrolling identifies areas that are unstable or “pumping” subgrade those areas should be repaired prior to the placement of any subsequent Structural Fill or other construction materials. Methods of stabilization include undercutting and moisture conditioning. The situation should be discussed with ECS to determine the appropriate procedure. Test pits may be excavated to explore the shallow subsurface materials to help in determining the cause of the observed unstable materials, and to assist in the evaluation of appropriate remedial actions to stabilize the subgrade.

5.2 EARTHWORK OPERATIONS

5.2.1 Existing Man-Placed Fill

Risk Associated with Undocumented Fill: Undocumented fill poses risks associated with undetected deleterious inclusions or soft zones within the fill and/or deleterious materials at the virgin ground/fill interface that are covered by the fill. The site has been modified previously therefore there is possible fill on the site and the fill must be considered undocumented as we have not been provided with in-place density test results for the fill or documentation of the preparation of the soil subgrade prior to fill placement. Undocumented fill poses risks associated with undetected deleterious inclusions or soft zones within the fill and/or deleterious materials at the virgin ground/fill interface that are covered by the fill. Debris material was encountered in the vicinity of the borings and soundings in the upper 1.5 to 2 feet at the time of our exploration in the vicinity of the previously demolished building.

The magnitude of settlement or subsidence associated with undocumented fill is generally related to the degree of compaction applied to the fill, inclusions of deleterious materials, and previous loadings. The only way to eliminate the risk associated with undocumented fill is to remove it, exposing the original ground and allowing evaluation of the quality of the material in the fill volume. We are not necessarily recommending the complete removal and replacement of the existing fill. However, the owner should understand that there is an inherent risk of constructing over undocumented fill, as localized areas of compressible soils, nested boulders, or buried debris can be present between the boring locations and can go unnoticed during the geotechnical study or during construction. Ultimately, the decision to build on undocumented fill is an economic decision that only the owner can make relative to the level of risk they consider acceptable should the new construction experience subgrade-related distress (e.g., building settlement, premature pavement distress, etc.). It has been our experience on similar sites that this risk can be managed by performing monitoring and testing during construction, as described in this report.

If the owner elects to leave the existing fill in-place, careful evaluations of the subgrade during construction should be considered critical to reducing the risk of unwanted post construction settlement. These evaluations may include proofrolling the subgrade soils, performing hand auger borings, and excavating test pits within previously filled areas. Localized remedial subgrade repairs should be anticipated. The mentioned evaluations would help in identifying soft, loose, or otherwise unsuitable areas of the fill, which would require remedial activities. Once the relevant facts to the nature of the undocumented fill are disclosed, the level of appropriate risk becomes a business decision that only the client can make.

5.2.2 Structural Fill

Prior to placement of structural fill, representative bulk samples (about 50 pounds) of on-site and/or off-site borrow should be submitted to ECS for laboratory testing, which will typically include Atterberg limits, natural moisture content, grain-size distribution, and moisture-density relationships (i.e., Proctors) for compaction. Import materials should be tested prior to being hauled to the site to determine if they meet project specifications. Alternatively, Proctor data from other accredited laboratories can be submitted if the test results are within the last 90 days.

Satisfactory Structural Fill Materials: Materials satisfactory for use as Structural Fill should consist of inorganic soils with the following engineering properties and compaction requirements.

STRUCTURAL FILL INDEX PROPERTIES (AASHTO A-3, A-2-4)	
Subject	Property
Building and Pavement Areas	LL < 30, PI<6
Max. Particle Size	3 inches
Fines Content	Max. 20 % > #200 sieve
Max. organic content	5% by dry weight

FILL COMPACTION REQUIREMENTS	
Subject	Requirement
Compaction Standard	Standard Proctor, ASTM D698
Required Compaction	95% of Max. Dry Density
Moisture Content	-2 to +2 % points of the soil's optimum value
Loose Thickness	8 inches prior to compaction

On-Site Borrow Suitability: Natural deposits of possible fill material are present near surface on the site. The on-site sands (SP, SP-SM, SM) in the upper approximately 12 feet below existing grades across the site with fines contents less than 20 percent should meet the recommendations for re-use as Structural Fill.

Fill Placement: Fill materials should not be placed on frozen soils, on frost-heaved soils, and/or on excessively wet soils. Borrow fill materials should not contain frozen materials at the time of placement, and frozen or frost-heaved soils should be removed prior to placement of structural fill or other fill soils and aggregates. Excessively wet soils or aggregates should be scarified, aerated, and moisture conditioned.

5.3 FOUNDATION AND SLAB OBSERVATIONS

Protection of Foundation Excavations: Exposure to the environment may weaken the soils at the footing bearing level if the foundation excavations remain open for too long a time. Therefore, foundation concrete should be placed the same day that excavations are made. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If the excavation must remain open overnight, or if rainfall becomes imminent while the bearing soils are exposed, a 1 to 3-inch thick "mud mat" of "lean" concrete should be placed on the bearing soils before the placement of reinforcing steel.

Footing Subgrade Observations: Most of the soils encountered on site at the foundation bearing elevation are anticipated to be suitable for support of the proposed structure. It is important to have ECS observe the foundation subgrade prior to placing foundation concrete, to confirm the bearing soils are what was anticipated.

Slab Subgrade Verification: Prior to placement of a drainage layer, the subgrade should be prepared in accordance with the recommendations found in **Section 5.1.2 Proofrolling**.

5.4 UTILITY INSTALLATIONS

Utility Subgrades: The soils encountered in our exploration are expected to be generally suitable for support of utility pipes. The pipe subgrades should be observed and probed for stability by ECS. Any loose or unsuitable materials encountered should be removed and replaced with suitable compacted Structural Fill, or pipe stone bedding material.

Utility Backfilling: The granular bedding material (AASHTO #57 stone) should be at least 4 inches thick, but not less than that specified by the civil engineer's project drawings and specifications. We recommend that the bedding materials be placed up to the spring line of the pipe. Fill placed for support of the utilities, as well as backfill over the utilities, should satisfy the requirements for structural fill and fill placement.

Excavation Safety: Excavations and slopes should be constructed and maintained in accordance with OSHA excavation safety standards. The contractor is solely responsible for designing, constructing, and maintaining stable temporary excavations and slopes. The contractor's responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. ECS is providing this information solely as a service to our client. ECS is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

6.0 CLOSING

ECS has prepared this report to guide the geotechnical-related design and construction aspects of the project. We performed these services in accordance with the standard of care expected of professionals in the industry performing similar services on projects of like size and complexity at this time in the region. No other representation, expressed or implied, and no warranty or guarantee is included or intended in this report.

The description of the proposed project is based on the limited information provided to ECS by NAVFAC and MBF Architects, PA. If any of this information is inaccurate, either due to our interpretation of the documents provided or site or design changes that may occur later, ECS should be contacted immediately so that we can review the report in light of the changes and provide additional or alternate recommendations as may be required.

We recommend that ECS be allowed to review the project's plans and specifications pertaining to our work so that we may ascertain consistency of those plans/specifications with the intent of the geotechnical report.

Field observations and quality assurance testing during earthwork and foundation installation are an extension of, and integral to, the geotechnical design. We recommend that ECS be retained to apply our expertise throughout the geotechnical phases of construction, and to provide consultation and recommendation should issues arise.

ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

APPENDIX A – Drawings

Site Vicinity Map (USGS 7.5-Minute Quadrangle Topographic Map)

Site Location Diagram (Aerial Map)

Boring Location Diagram (Topographic Map)

Boring Location Diagram

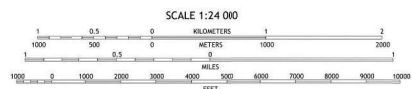


Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1:50 meter grid interval Transverse Mercator, Zone 18S.
This map is not a legal document. Boundaries may be
generalized for this map scale. Private lands within government
reservations may not be shown. Obtain permission before
entering private lands.

Imagery:.....NAP September 2020 - September 2020
Roads:.....U.S. Census Bureau, 2016
Names:.....National Hydrography Dataset, 1980 - 2012
Hydrography:.....National Hydrography Dataset, 2006 - 2018
Contours:.....Multiple sources: National Elevation Dataset, 2019
Boundaries:.....Multiple sources: new roadless file, 2019
Wetlands:.....FWS National Wetlands Inventory Not Available

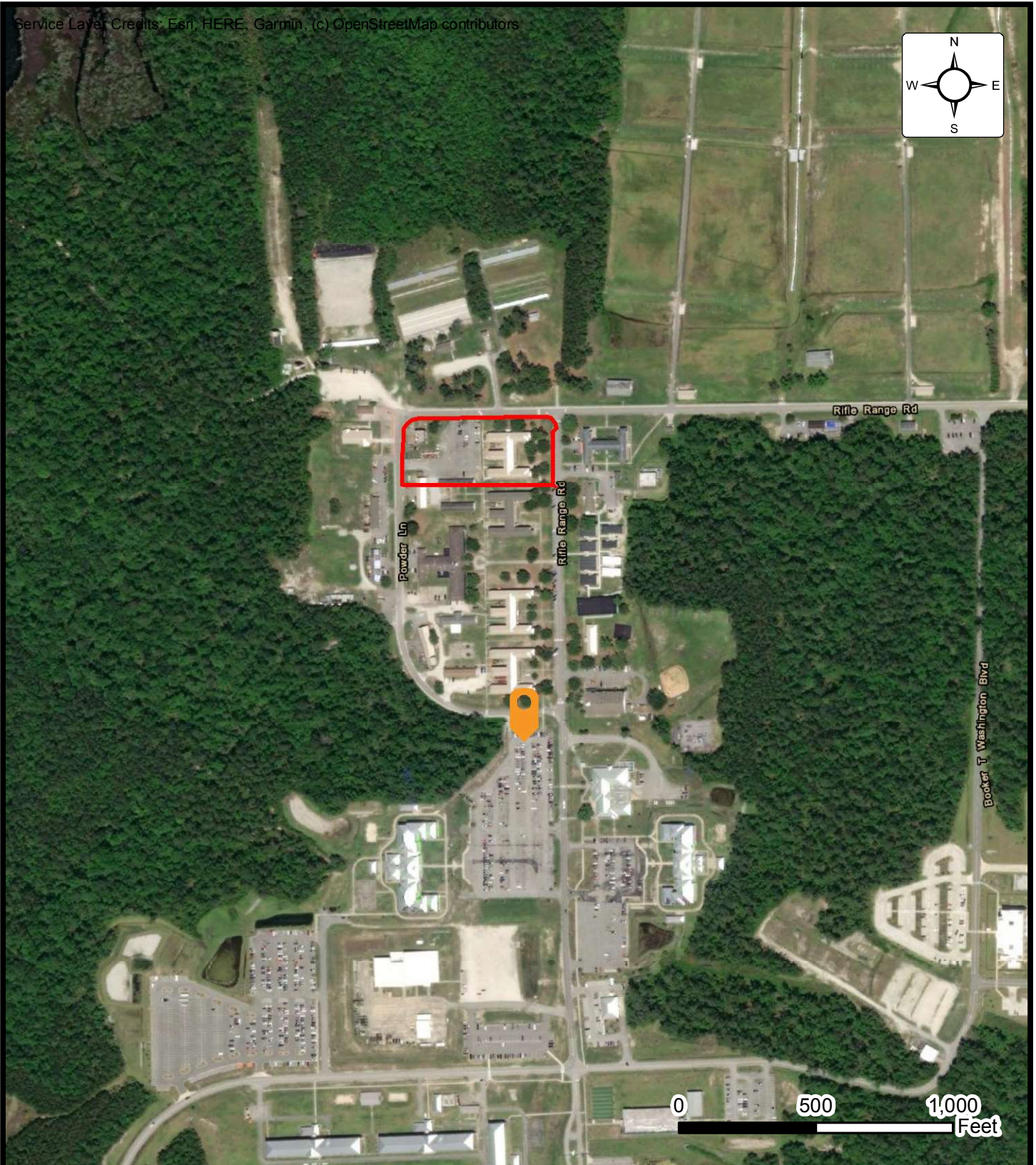
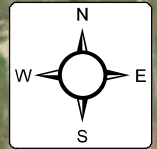
UTM GRID AND 2019 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

UTM Zone 18S
Magnetic Declination
1980



CONTOUR INTERVAL: 5 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988
This map was produced to conform with the
National Geospatial Program US Topo Product Standard.





SITE LOCATION DIAGRAM P1594 RR1 REPLACEMENT

STONE BAY, SNEADS FERRY, NC

MBF ARCHITECTS PA

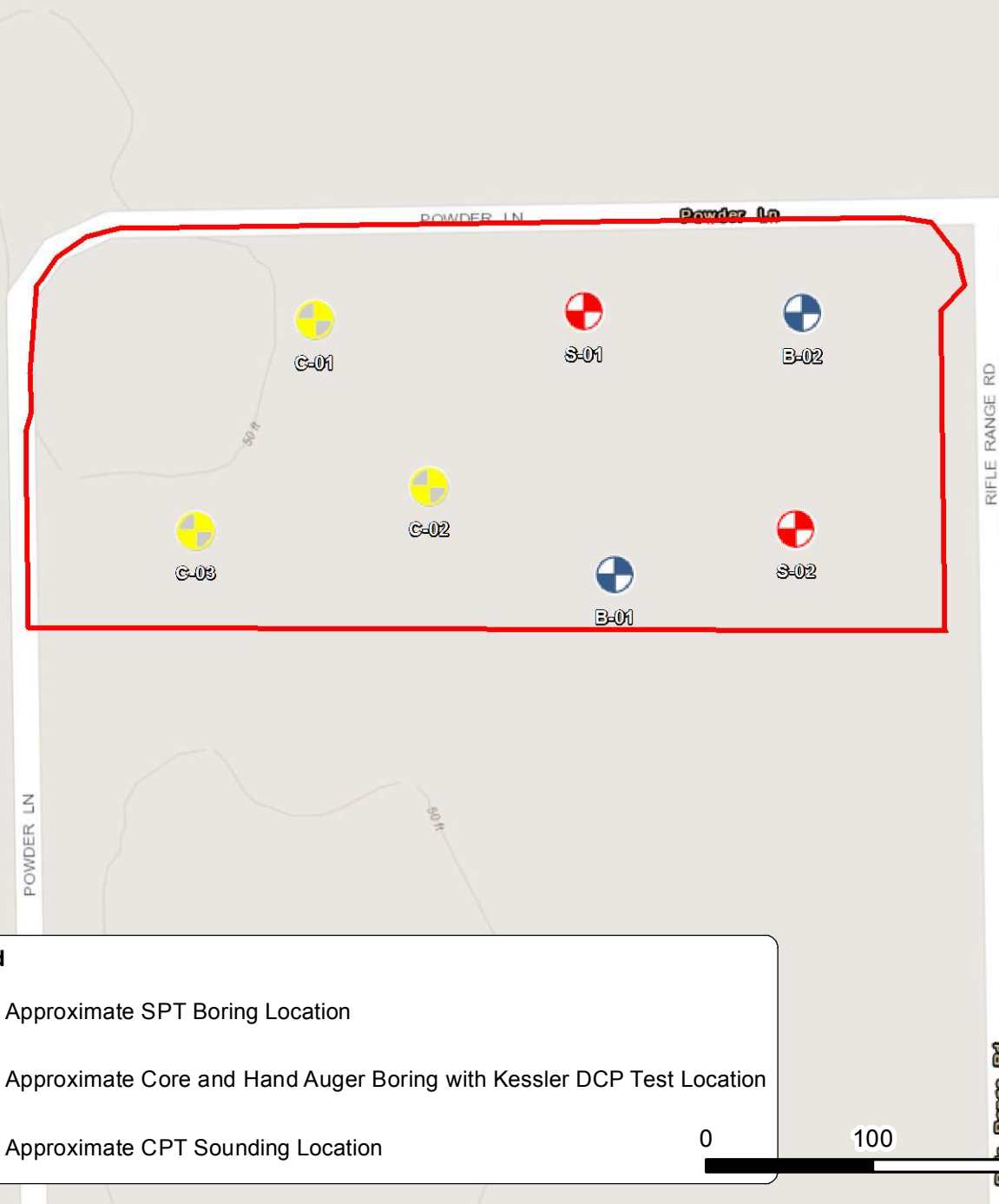
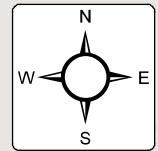
ENGINEER
WEG

SCALE
AS NOTED

PROJECT NO.
22:32370

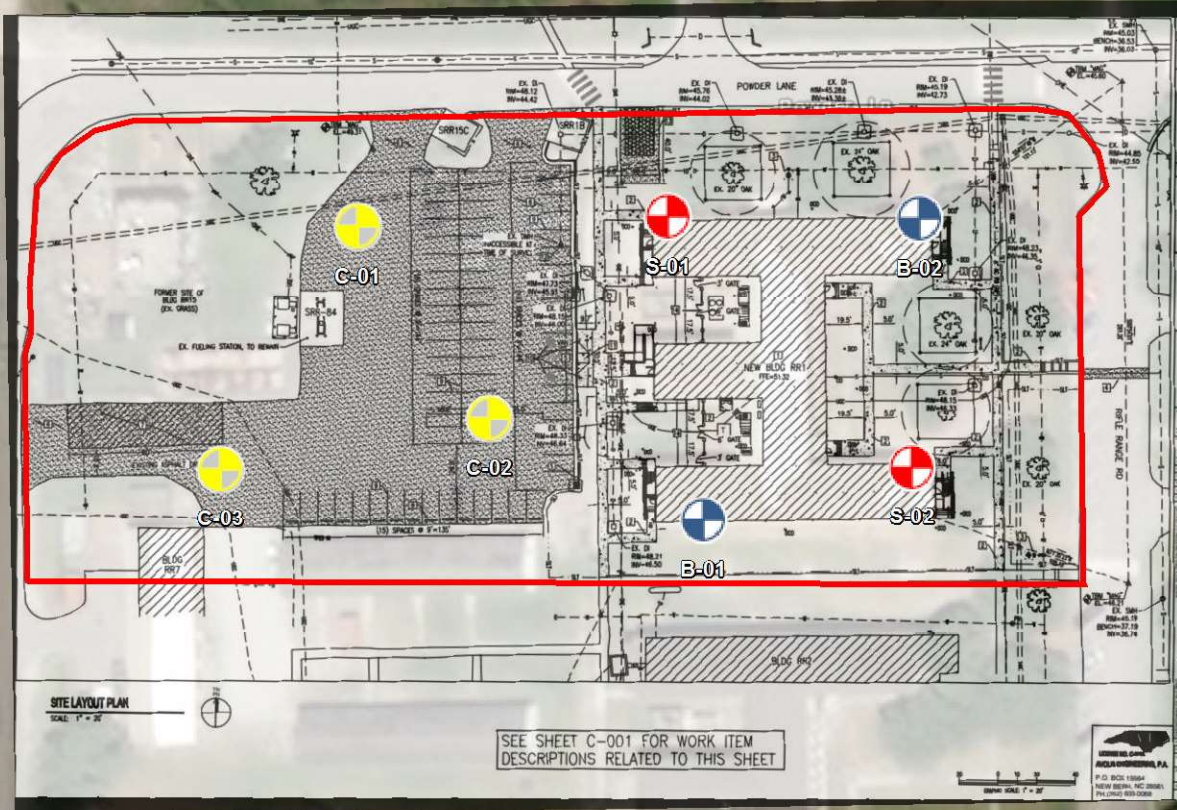
FIGURE
1 OF 3

DATE
1/20/2023






BORING LOCATION DIAGRAM
P1594 RR1 REPLACEMENT
STONE BAY, SNEADS FERRY, NORTH CAROLINA
MBF ARCHITECTS PA

ENGINEER WEG
SCALE AS NOTED
PROJECT NO. 22:32370
FIGURE 2 OF 3
DATE 1/20/2023



Legend

-  Approximate SPT Boring Location
-  Approximate Core and Hand Auger Boring with Kessler DCP Test Location
-  Approximate CPT Sounding Location

0 100 200 Feet



BORING LOCATION DIAGRAM P1594 RR1 REPLACEMENT

STONE BAY, SNEADS FERRY, NORTH CAROLINA

MBF ARCHITECTS PA

ENGINEER
WEG

SCALE
AS NOTED

PROJECT NO.
22:32370

FIGURE
3 OF 3

DATE
1/20/2023

APPENDIX B – Field Operations

Reference Notes for Boring Logs

SPT Boring Logs (B-1 and B-2)

Subsurface Soil Profile

Reference Notes for CPT Soundings

Cone Penetration Test Sounding Logs (S-1 and S-2)

Dissipation Test Results (S-1 and S-2)

Hand Auger Boring Logs (C-1 through C-3)

Kessler DCP Test Data (C-1 through C-3)

Photos of Cores (C-1 through C-3)



REFERENCE NOTES FOR BORING LOGS

MATERIAL^{1,2}

	ASPHALT
	CONCRETE
	GRAVEL
	TOPSOIL
	VOID
	BRICK
	AGGREGATE BASE COURSE
	GW WELL-GRADED GRAVEL gravel-sand mixtures, little or no fines
	GP POORLY-GRADED GRAVEL gravel-sand mixtures, little or no fines
	GM SILTY GRAVEL gravel-sand-silt mixtures
	GC CLAYEY GRAVEL gravel-sand-clay mixtures
	SW WELL-GRADED SAND gravelly sand, little or no fines
	SP POORLY-GRADED SAND gravelly sand, little or no fines
	SM SILTY SAND sand-silt mixtures
	SC CLAYEY SAND sand-clay mixtures
	ML SILT non-plastic to medium plasticity
	MH ELASTIC SILT high plasticity
	CL LEAN CLAY low to medium plasticity
	CH FAT CLAY high plasticity
	OL ORGANIC SILT or CLAY non-plastic to low plasticity
	OH ORGANIC SILT or CLAY high plasticity
	PT PEAT highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS

SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION

DESIGNATION	PARTICLE SIZES
Boulders	12 inches (300 mm) or larger
Cobbles	3 inches to 12 inches (75 mm to 300 mm)
Gravel: Coarse	¾ inch to 3 inches (19 mm to 75 mm)
Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand: Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")	<0.074 mm (smaller than a No. 200 sieve)

COHESIVE SILTS & CLAYS

UNCONFINED COMPRESSION STRENGTH, QP ⁴	SPT ⁵ (BPF)	CONSISTENCY ⁷ (COHESIVE)
<0.25	<2	Very Soft
0.25 - <0.50	2 - 4	Soft
0.50 - <1.00	5 - 8	Firm
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

RELATIVE AMOUNT ⁷	COARSE GRAINED (%) ⁸	FINE GRAINED (%) ⁸
Trace	≤5	≤5
With	10 - 20	10 - 25
Adjective (ex: "Silty")	25 - 45	30 - 45

GRAVELS, SANDS & NON-COHESIVE SILTS

SPT ⁵	DENSITY
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

WATER LEVELS⁶

	WL (First Encountered)
	WL (Completion)
	WL (Seasonal High Water)
	WL (Stabilized)

FILL AND ROCK

FILL	POSSIBLE FILL	PROBABLE FILL	ROCK

¹Classifications and symbols per ASTM D 2488-17 (Visual-Manual Procedure) unless noted otherwise.

²To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.

³Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-FILL)].




⁴Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).






⁵Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf). SPT correlations per 7.4.2 Method B and need to be corrected if using an auto hammer.





⁶The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.

⁷Minor deviation from ASTM D 2488-17 Note 14.




⁸Percentages are estimated to the nearest 5% per ASTM D 2488-17.

CLIENT: MBF Architects PA				PROJECT NO.: 22:32370		BORING NO.: B-01		SHEET: 1 of 3		
PROJECT NAME: P1594 RR1 Replacement				DRILLER/CONTRACTOR: ECS						
SITE LOCATION: Powder Lane, Sneads Ferry, North Carolina, 28445								LOSS OF CIRCULATION 		
NORTHING: 310553.6		EASTING: 2466567.2		STATION:		SURFACE ELEVATION: 48.50		BOTTOM OF CASING 		

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %				
									20	40	60	80	100	1		2	3	4	5
														10		20	30	40	50
5	S-1	SS	24	24	(SM) SILTY FINE SAND, brown, very loose to medium dense, moist to saturated		44	1-2-3-4 (5)	⊗										
	S-2	SS	24	24			44	3-3-5-6 (8)	⊗										
	S-3	SS	24	24			44	7-6-8-10 (14)	⊗										
	S-4	SS	24	24			44	1-6-7-7 (13)	⊗										
10	S-5	SS	24	24	(SP-SM) FINE SAND WITH SILT, brown, very loose, saturated		39	WOH-WOH-1- WOH (1)	⊗							43.5			
	S-6	SS	24	24			39	WOH-1- WOH-1 (1)	⊗										
15	S-7	SS	24	24	(SP) FINE SAND, brown, medium dense, saturated		34	2-5-7-6 (12)	⊗							26.5			
							34												
20	S-8	SS	24	24	(SM) SILTY FINE TO SAND, gray, medium dense, saturated		29	7-5-7-5 (12)	⊗							26.7			
							29												
25	S-9	SS	24	24	(ML) SANDY SILT, gray/blue, very soft, saturated		24	WOH-WOH- WOH-WOH (0)	⊗										
							24												
30	S-10	SS	24	24			19	WOH-WOH- WOH-WOH (0)	⊗										
CONTINUED ON NEXT PAGE																			

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL						
<div>  WL (First Encountered) </div>	<div>  WL (Completion) 7.66 </div>	<div>  WL (Seasonal High Water) 4.20 </div>	<div>  WL (Stabilized) </div>	<div> BORING STARTED: Dec 19 2022 </div> <div> BORING COMPLETED: Dec 19 2022 </div> <div> EQUIPMENT: Track </div>	<div> CAVE IN DEPTH: </div> <div> HAMMER TYPE: Auto </div> <div> LOGGED BY: REG </div>	<div> DRILLING METHOD: Mud rotary </div>




GEOTECHNICAL BOREHOLE LOG

CLIENT: MBF Architects PA				PROJECT NO.: 22:32370		BORING NO.: B-01		SHEET: 2 of 3		
PROJECT NAME: P1594 RR1 Replacement				DRILLER/CONTRACTOR: ECS						
SITE LOCATION: Powder Lane, Sneads Ferry, North Carolina, 28445								LOSS OF CIRCULATION 		
NORTHING: 310553.6		EASTING: 2466567.2		STATION:		SURFACE ELEVATION: 48.50		BOTTOM OF CASING 		




DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		LIQUID LIMIT / PLASTIC LIMIT		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %	
									20	40	60	80	100					
														RQD	REC			
35	S-11	SS	24	24	(ML) SANDY SILT, gray/blue, very soft, saturated		14	WOH-WOH-WOH-WOH (0)	28	32							39.5	
40	S-12	SS	24	24	(CL) SANDY LEAN CLAY, gray/blue, very soft, saturated		9	WOH-WOH-WOH-WOH (0)	22	31							36.5	
45	S-13	SS	24	24			4	WOH-WOH-1-1 (1)										
50	S-14	SS	24	24	(SM) SILTY FINE SAND, gray/blue, dense, saturated, with shell fragments		-1	15-20-23-24 (43)										
55	S-15	SS	24	24	(SM) SILTY FINE SAND, gray/blue, medium dense, saturated		-6	6-7-7-14 (14)										
60	S-16	SS	24	24	(ML) SANDY SILT, gray/blue, very stiff, saturated		-11	5-7-17-23 (24)									24.9	
CONTINUED ON NEXT PAGE																		

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL			
<div> <div></div> WL (First Encountered) </div> <div> <div></div> WL (Completion) </div> <div> <div></div> WL (Seasonal High Water) </div> <div> <div></div> WL (Stabilized) </div>	<div> <div></div> 7.66 </div> <div> <div></div> 4.20 </div>	<div> <div></div> BORING STARTED: Dec 19 2022 </div> <div> <div></div> BORING COMPLETED: Dec 19 2022 </div> <div> <div></div> EQUIPMENT: Track </div>	<div> <div></div> CAVE IN DEPTH: </div> <div> <div></div> HAMMER TYPE: Auto </div> <div> <div></div> DRILLING METHOD: Mud rotary </div>

GEOTECHNICAL BOREHOLE LOG

CLIENT: MBF Architects PA				PROJECT NO.: 22:32370		BORING NO.: B-01		SHEET: 3 of 3			
PROJECT NAME: P1594 RR1 Replacement				DRILLER/CONTRACTOR: ECS							
SITE LOCATION: Powder Lane, Sneads Ferry, North Carolina, 28445								LOSS OF CIRCULATION			
NORTHING: 310553.6		EASTING: 2466567.2		STATION:		SURFACE ELEVATION: 48.50		BOTTOM OF CASING			
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	⊗ STANDARD PENETRATION BLOWS/FT		△ LIQUID LIMIT
									20 40 60 80 100		×
								ROCK QUALITY DESIGNATION & RECOVERY		○ CALIBRATED PENETROMETER TSF	
								— RQD		1 2 3 4 5	
								— REC		● WATER CONTENT % [FINES CONTENT] %	
										10 20 30 40 50	
65	S-17	SS	24	24	(ML) SANDY SILT, gray/blue, very stiff, saturated		-16	7-12-15-26 (27)	⊗ 27		
					END OF BORING AT 65 FT						
70							-21				
75							-26				
80							-31				
85							-36				
90							-41				
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL											
▽ WL (First Encountered)				BORING STARTED: Dec 19 2022				CAVE IN DEPTH:			
▼ WL (Completion) 7.66				BORING COMPLETED: Dec 19 2022				HAMMER TYPE: Auto			
▼ WL (Seasonal High Water) 4.20				EQUIPMENT: Track				LOGGED BY: REG		DRILLING METHOD: Mud rotary	
▽ WL (Stabilized)											
GEOTECHNICAL BOREHOLE LOG											






CLIENT: MBF Architects PA						PROJECT NO.: 22:32370		BORING NO.: B-02		SHEET: 1 of 3																																																																																																																																																																																																			
PROJECT NAME: P1594 RR1 Replacement						DRILLER/CONTRACTOR: ECS																																																																																																																																																																																																							
SITE LOCATION: Powder Lane, Sneads Ferry, North Carolina, 28445								LOSS OF CIRCULATION 																																																																																																																																																																																																					
NORTHING: 310706.5			EASTING: 2466709.1			STATION:		SURFACE ELEVATION: 48.50		BOTTOM OF CASING 																																																																																																																																																																																																			
<table border="1"><thead><tr><th rowspan="2">DEPTH (FT)</th><th rowspan="2">SAMPLE NUMBER</th><th rowspan="2">SAMPLE TYPE</th><th rowspan="2">SAMPLE DIST. (IN)</th><th rowspan="2">RECOVERY (IN)</th><th rowspan="2">DESCRIPTION OF MATERIAL</th><th rowspan="2">WATER LEVELS</th><th rowspan="2">ELEVATION (FT)</th><th rowspan="2">BLOWS/6"</th><th colspan="2">ROCK QUALITY DESIGNATION & RECOVERY</th><th colspan="2">LIQUID LIMIT / PLASTIC LIMIT</th><th colspan="2">CALIBRATED PENETROMETER TSF</th></tr><tr><th>STANDARD</th><th>PENETRATION BLOWS/FT</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr></thead><tbody><tr><td rowspan="2"></td><td>S-1</td><td>SS</td><td>24</td><td>24</td><td>(SM) SILTY FINE SAND, brown, very loose to medium dense, moist</td><td rowspan="2"></td><td rowspan="2">44</td><td>1-2-1-3 (3)</td><td></td><td>20</td><td>40</td><td>60</td><td>80</td><td>100</td><td rowspan="2">18.5</td></tr><tr><td>S-2</td><td>SS</td><td>24</td><td>24</td><td></td><td>3-4-8-9 (12)</td><td></td><td>12</td></tr><tr><td>5</td><td>S-3</td><td>SS</td><td>24</td><td>24</td><td>(SP) FINE SAND, brown, medium dense, moist</td><td rowspan="2"></td><td rowspan="2">39</td><td>5-6-9-12 (15)</td><td></td><td>15</td><td></td><td></td><td></td><td></td><td rowspan="2">33.7</td></tr><tr><td rowspan="2">10</td><td>S-4</td><td>SS</td><td>24</td><td>24</td><td>(SM) SILTY FINE SAND, brown, very loose to medium dense, moist to saturated</td><td>1-3-8-11 (11)</td><td></td><td>11</td></tr><tr><td>S-5</td><td>SS</td><td>24</td><td>24</td><td></td><td>2-WOH-1-WOH (1)</td><td></td><td>1</td></tr><tr><td rowspan="2">15</td><td>S-6</td><td>SS</td><td>24</td><td>24</td><td></td><td>WOH-1-8-4 (9)</td><td></td><td>9</td></tr><tr><td>S-7</td><td>SS</td><td>24</td><td>24</td><td></td><td>WOH-WOH-2-5 (2)</td><td></td><td>2</td></tr><tr><td rowspan="2">20</td><td>S-8</td><td>SS</td><td>24</td><td>24</td><td>(SM) SILTY FINE TO MEDIUM SAND, gray, very loose, saturated</td><td rowspan="2"></td><td rowspan="2">29</td><td>3-3-1-WOH (4)</td><td></td><td>4</td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td rowspan="2">25</td><td>S-9</td><td>SS</td><td>24</td><td>24</td><td>(ML) SANDY SILT, gray/blue, very soft, saturated</td><td rowspan="2"></td><td rowspan="2">24</td><td>WOH-WOH-WOH-WOH (0)</td><td></td><td>0</td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>30</td><td>S-10</td><td>SS</td><td>24</td><td>24</td><td></td><td rowspan="2"></td><td rowspan="2">19</td><td>WOH-WOH-WOH-WOH (0)</td><td></td><td>0</td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td colspan="14">CONTINUED ON NEXT PAGE</td></tr></tbody></table>														DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	ROCK QUALITY DESIGNATION & RECOVERY		LIQUID LIMIT / PLASTIC LIMIT		CALIBRATED PENETROMETER TSF		STANDARD	PENETRATION BLOWS/FT	1	2	3	4	5		S-1	SS	24	24	(SM) SILTY FINE SAND, brown, very loose to medium dense, moist		44	1-2-1-3 (3)		20	40	60	80	100	18.5	S-2	SS	24	24		3-4-8-9 (12)		12	5	S-3	SS	24	24	(SP) FINE SAND, brown, medium dense, moist		39	5-6-9-12 (15)		15					33.7	10	S-4	SS	24	24	(SM) SILTY FINE SAND, brown, very loose to medium dense, moist to saturated	1-3-8-11 (11)		11	S-5	SS	24	24		2-WOH-1-WOH (1)		1	15	S-6	SS	24	24		WOH-1-8-4 (9)		9	S-7	SS	24	24		WOH-WOH-2-5 (2)		2	20	S-8	SS	24	24	(SM) SILTY FINE TO MEDIUM SAND, gray, very loose, saturated		29	3-3-1-WOH (4)		4																	25	S-9	SS	24	24	(ML) SANDY SILT, gray/blue, very soft, saturated		24	WOH-WOH-WOH-WOH (0)		0																	30	S-10	SS	24	24			19	WOH-WOH-WOH-WOH (0)		0																		CONTINUED ON NEXT PAGE													
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	ROCK QUALITY DESIGNATION & RECOVERY		LIQUID LIMIT / PLASTIC LIMIT		CALIBRATED PENETROMETER TSF																																																																																																																																																																																																
									STANDARD	PENETRATION BLOWS/FT	1	2	3	4	5																																																																																																																																																																																														
	S-1	SS	24	24	(SM) SILTY FINE SAND, brown, very loose to medium dense, moist		44	1-2-1-3 (3)		20	40	60	80	100	18.5																																																																																																																																																																																														
	S-2	SS	24	24				3-4-8-9 (12)		12																																																																																																																																																																																																			
5	S-3	SS	24	24	(SP) FINE SAND, brown, medium dense, moist		39	5-6-9-12 (15)		15					33.7																																																																																																																																																																																														
10	S-4	SS	24	24	(SM) SILTY FINE SAND, brown, very loose to medium dense, moist to saturated			1-3-8-11 (11)		11																																																																																																																																																																																																			
	S-5	SS	24	24		2-WOH-1-WOH (1)		1																																																																																																																																																																																																					
15	S-6	SS	24	24		WOH-1-8-4 (9)		9																																																																																																																																																																																																					
	S-7	SS	24	24		WOH-WOH-2-5 (2)		2																																																																																																																																																																																																					
20	S-8	SS	24	24	(SM) SILTY FINE TO MEDIUM SAND, gray, very loose, saturated		29	3-3-1-WOH (4)		4																																																																																																																																																																																																			
25	S-9	SS	24	24	(ML) SANDY SILT, gray/blue, very soft, saturated		24	WOH-WOH-WOH-WOH (0)		0																																																																																																																																																																																																			
30	S-10	SS	24	24			19	WOH-WOH-WOH-WOH (0)		0																																																																																																																																																																																																			
CONTINUED ON NEXT PAGE																																																																																																																																																																																																													
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL																																																																																																																																																																																																													
WL (First Encountered)						BORING STARTED: Dec 19 2022				CAVE IN DEPTH:																																																																																																																																																																																																			
WL (Completion) 7.50						BORING COMPLETED: Dec 19 2022				HAMMER TYPE: Auto																																																																																																																																																																																																			
WL (Seasonal High Water) 4.50						EQUIPMENT: Track				LOGGED BY: REG																																																																																																																																																																																																			
WL (Stabilized)										DRILLING METHOD: Mud rotary																																																																																																																																																																																																			
GEOTECHNICAL BOREHOLE LOG																																																																																																																																																																																																													

CLIENT: MBF Architects PA				PROJECT NO.: 22:32370		BORING NO.: B-02		SHEET: 2 of 3		
PROJECT NAME: P1594 RR1 Replacement				DRILLER/CONTRACTOR: ECS						
SITE LOCATION: Powder Lane, Sneads Ferry, North Carolina, 28445								LOSS OF CIRCULATION 		
NORTHING: 310706.5		EASTING: 2466709.1		STATION:		SURFACE ELEVATION: 48.50		BOTTOM OF CASING 		

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		WATER CONTENT % [FINES CONTENT] %					
									20	40	60	80	100	1	2	3	4	5
					(ML) SANDY SILT, gray/blue, very soft, saturated													
35	S-11	SS	24	24			14	WOH-WOH-WOH-WOH (0)										
40	S-12	SS	24	24			9	WOH-WOH-WOH-WOH (0)										
45	S-13	SS	24	24			4	WOH-WOH-WOH-1 (0)										
50	S-14	SS	24	24	(SM) SILTY FINE SAND, gray/blue, medium dense, saturated, with shell fragments		-1	10-16-14-14 (30)										
55	S-15	SS	24	24	(SM) SILTY FINE SAND, gray/blue, medium dense, saturated		-6	5-7-9-16 (16)										
60	S-16	SS	24	24			-11	5-13-17-20 (30)										
CONTINUED ON NEXT PAGE																		

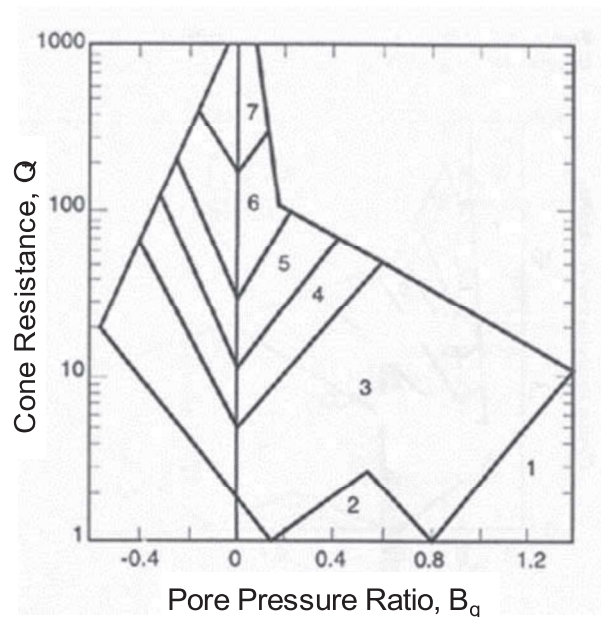
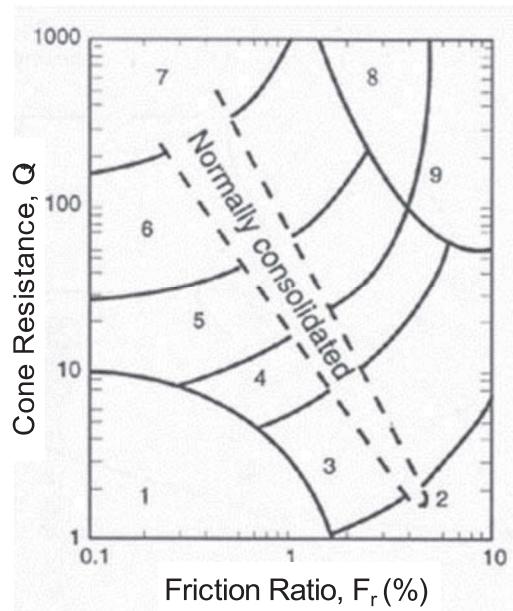
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL			
<div> <div></div> <div>WL (First Encountered)</div> </div> <div> <div></div> <div>WL (Completion)</div> </div> <div> <div></div> <div>WL (Seasonal High Water)</div> </div> <div> <div></div> <div>WL (Stabilized)</div> </div>	<div> <div></div> <div>7.50</div> </div> <div> <div></div> <div>4.50</div> </div>	<div> <div>BORING STARTED:</div> <div>Dec 19 2022</div> </div> <div> <div>BORING COMPLETED:</div> <div>Dec 19 2022</div> </div> <div> <div>EQUIPMENT:</div> <div>Track</div> </div>	<div> <div>CAVE IN DEPTH:</div> <div></div> </div> <div> <div>HAMMER TYPE:</div> <div>Auto</div> </div> <div> <div>LOGGED BY:</div> <div>REG</div> </div> <div> <div>DRILLING METHOD:</div> <div>Mud rotary</div> </div>

GEOTECHNICAL BOREHOLE LOG	
----------------------------------	--

CLIENT: MBF Architects PA				PROJECT NO.: 22:32370		BORING NO.: B-02		SHEET: 3 of 3			
PROJECT NAME: P1594 RR1 Replacement				DRILLER/CONTRACTOR: ECS							
SITE LOCATION: Powder Lane, Sneads Ferry, North Carolina, 28445								LOSS OF CIRCULATION			
NORTHING: 310706.5		EASTING: 2466709.1		STATION:		SURFACE ELEVATION: 48.50		BOTTOM OF CASING			
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT		<div>△ LIQUID LIMIT × PLASTIC LIMIT</div> <div>○ CALIBRATED PENETROMETER TSF</div> <div>1 2 3 4 5</div> <div>● WATER CONTENT % [FINES CONTENT] %</div> <div>10 20 30 40 50</div>
									20 40 60 80 100		
ROCK QUALITY DESIGNATION & RECOVERY											
<div>— RQD</div> <div>— REC</div>											
65	S-17	SS	24	24	(SM) SILTY FINE SAND, gray/blue, medium dense, saturated		-16	7-14-14-25 (28)	 28		
					END OF BORING AT 65 FT						
70							-21				
75							-26				
80							-31				
85							-36				
90							-41				
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL											
<div>☒ WL (First Encountered)</div>					BORING STARTED: Dec 19 2022			CAVE IN DEPTH:			
<div>▼ WL (Completion) 7.50</div>					BORING COMPLETED: Dec 19 2022			HAMMER TYPE: Auto			
<div>☒ WL (Seasonal High Water) 4.50</div>					EQUIPMENT: Track		LOGGED BY: REG		DRILLING METHOD: Mud rotary		
<div>☒ WL (Stabilized)</div>											
GEOTECHNICAL BOREHOLE LOG											

REFERENCE NOTES FOR CONE PENETRATION TEST (CPT) SOUNDINGS

In the CPT sounding procedure (ASTM-D-5778), an electronically instrumented cone penetrometer is hydraulically advanced through soil to measure point resistance (q_c), pore water pressure (u_2), and sleeve friction (f_s). These values are recorded continuously as the cone is pushed to the desired depth. CPT data is corrected for depth and used to estimate soil classifications and intrinsic soil parameters such as angle of internal friction, preconsolidation pressure, and undrained shear strength. The graphs below represent one of the accepted methods of CPT soil behavior classification (Robertson, 1990).



1. Sensitive, Fine Grained
2. Organic Soils-Peats
3. Clays; Clay to Silty Clay
4. Clayey Silt to Silty Clay
5. Silty Sand to Sandy Silt

6. Clean Sands to Silty Sands
7. Gravelly Sand to Sand
8. Very Stiff Sand to Clayey Sand
9. Very Stiff Fine Grained

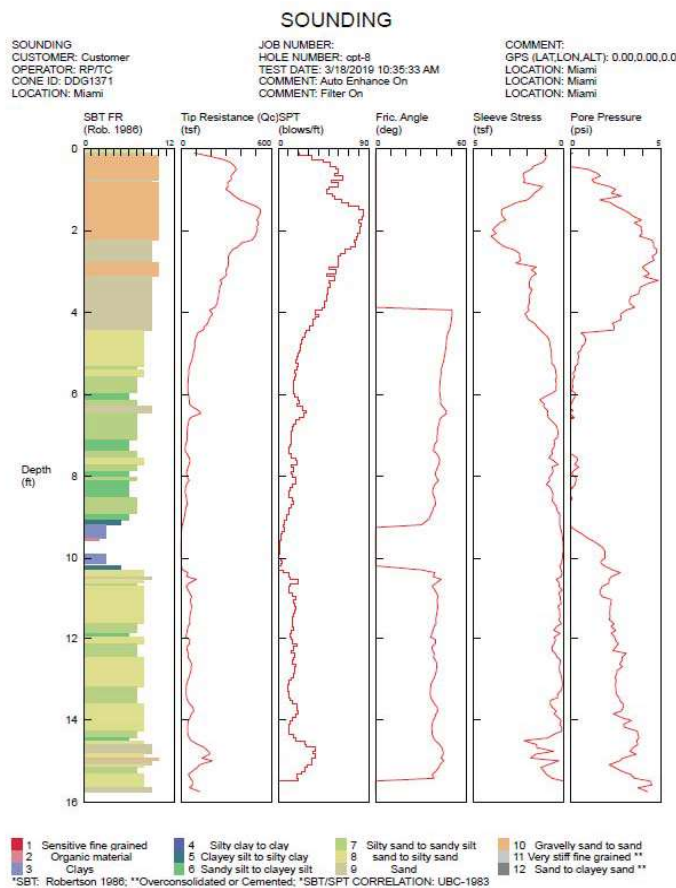
The following table presents a correlation of corrected cone tip resistance (q_t) to soil consistency or relative density:

SAND		SILT/CLAY	
Corrected Cone Tip Resistance (q_t) (tsf)	Relative Density	Corrected Cone Tip Resistance (q_t) (tsf)	Relative Density
<20	Very Loose	<5	Very Soft
20-40	Loose	5-10	Soft
40-120	Medium Dense	10-15	Firm
		15-30	Stiff
120-200	Dense	30-45	Very Stiff
		45-60	Hard
>200	Very Dense	>60	Very Hard



SUBSURFACE EXPLORATION PROCEDURE: CONE PENETRATION TESTING (CPT) ASTM D 5778

In the CPT sounding procedure, an electronically instrumented cone penetrometer is hydraulically advanced through soil to measure point resistance (q_c), pore water pressure (U_2), and sleeve friction (f_s). These values are recorded continuously as the cone is pushed to the desired depth. CPT data is corrected for depth and used to estimate soil classifications and intrinsic soil parameters such as angle of internal friction, pre-consolidation pressure, and undrained shear strength.



CPT Procedure:

- Involves the direct push of an electronically instrumented cone penetrometer* through the soil
- Values are recorded continuously
- CPT data is corrected and correlated to soil parameters

*CPT Penetrometer Size May Vary



ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28403
ECS Project # 22-32370

CPT: S-1

Total depth: 56.10 ft, Date: 12/16/2022

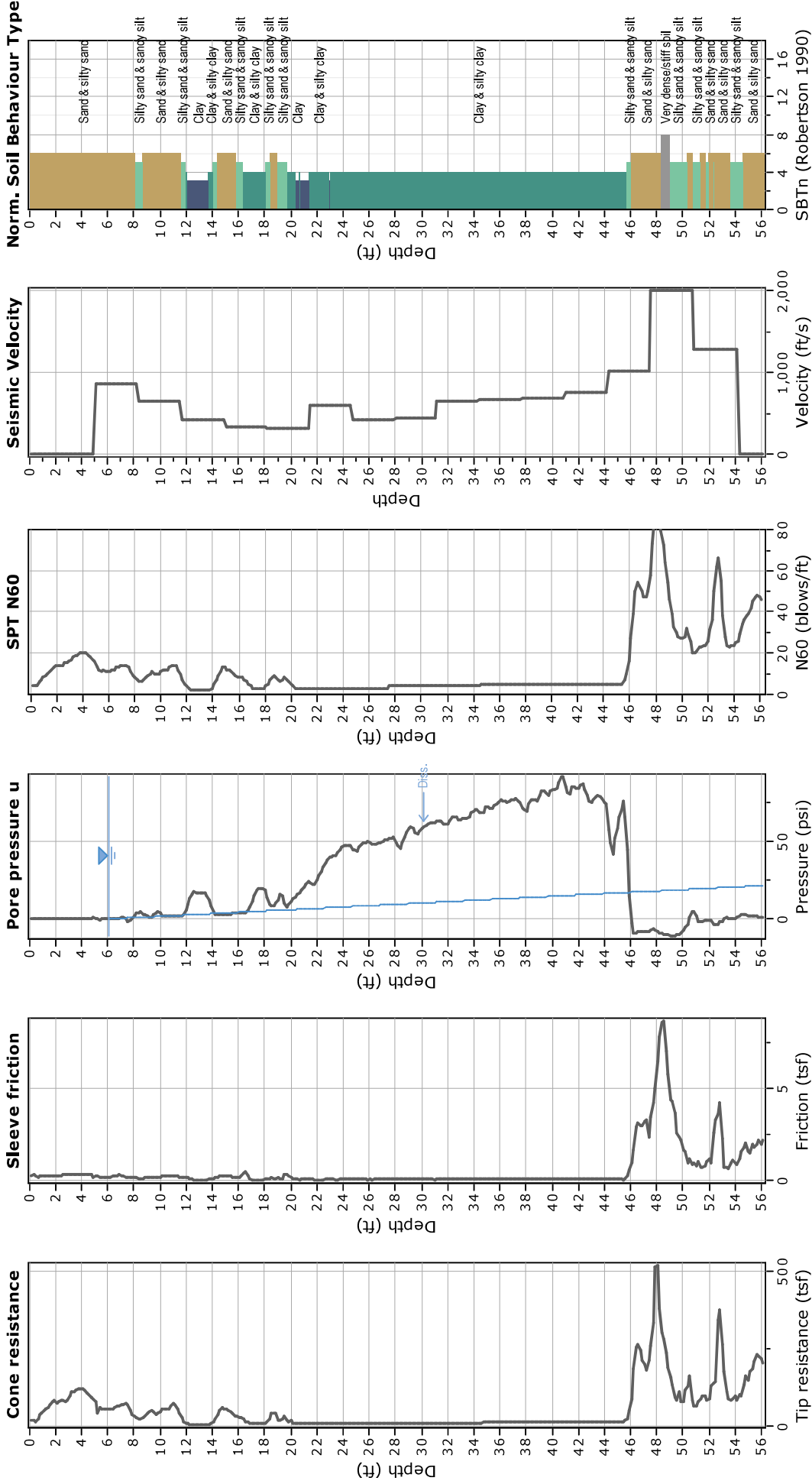
Surface Elevation: 49.00 ft

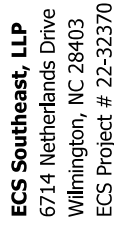
Coords: lat 34.5937° lon -77.4497°

Cone Operator: Matt Wiggins

Project: P-1591 RR1 Replacement

Location: Stone Bay, Onslow County, North Carolina

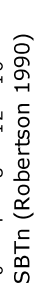




Total depth: 65.94 ft, Date: 12/16/2022
Surface Elevation: 48.5 ft

Location: Stone Bay, Onslow County, North Carolina

Coords: lat 34.5933° lon -77.4493°





Project: P-1591 RR1 Replacement

Location: Stone Bay, Onslow County, North Carolina

Dissipation Tests Results

Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for t_{50} , which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction c_h was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position

r: piezocone radius

I_r : stiffness index, equal to shear modulus G divided by the undrained strength of clay (S_u).

t_{50} : time corresponding to 50% consolidation

Permeability estimates based on dissipation test

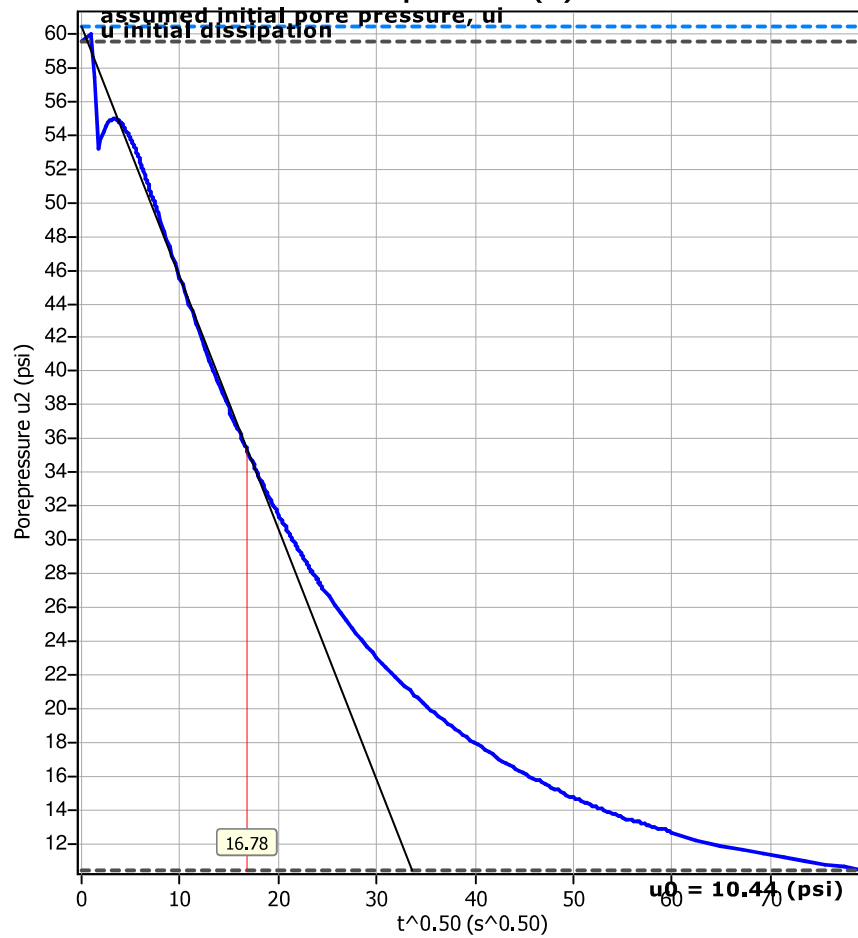
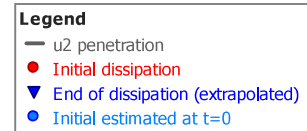
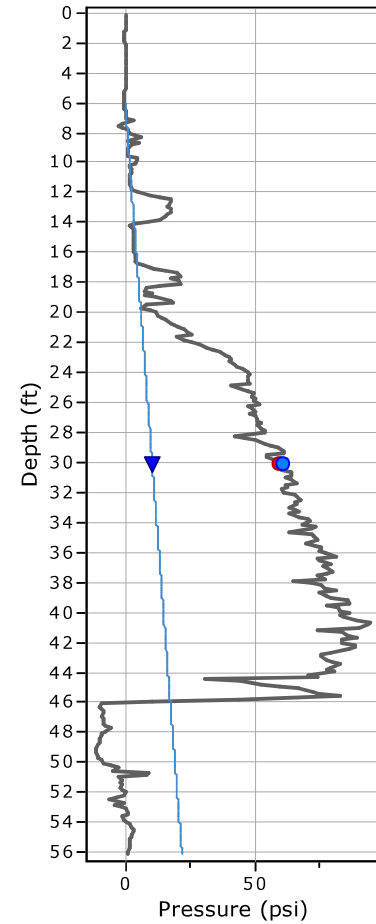
The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction (c_h) which is influenced by a combination of the soil permeability (k_h) and compressibility (M), as defined by the following:

$$k_h = c_h \times \gamma_w / M$$

where: M is the 1-D constrained modulus and γ_w is the unit weight of water, in compatible units.

Tabular results

CPTU Borehole	Depth (ft)	$(t_{50})^{0.50}$	t_{50} (s)	t_{50} (years)	G/ S_u	c_h (ft ² /s)	c_h (ft ² /year)	M (tsf)	k_h (ft/s)
S-1	30.18	16.8	282	8.93E-006	450121.19	1.95E-004	6165	66.92	9.12E-008

Piezocene Dissipation Test: S-1**Depth: 30.18 (ft)****Pore pressure**



ECS Southeast, LLP
6714 Netherlands Drive
Wilmington, NC 28403
ECS Project # 22-32370

CPT: S-2

Total depth: 65.94 ft, Date: 12/16/2022

Surface Elevation: 48.5 ft

Coords: lat 34.5933° lon -77.4493°

Cone Operator: Matt Wiggins

Project: P-1591 RR1 Replacement

Location: Stone Bay, Onslow County, North Carolina

Dissipation Tests Results

Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for t_{50} , which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction c_h was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position

r: piezocone radius

I_r : stiffness index, equal to shear modulus G divided by the undrained strength of clay (S_u).

t_{50} : time corresponding to 50% consolidation

Permeability estimates based on dissipation test

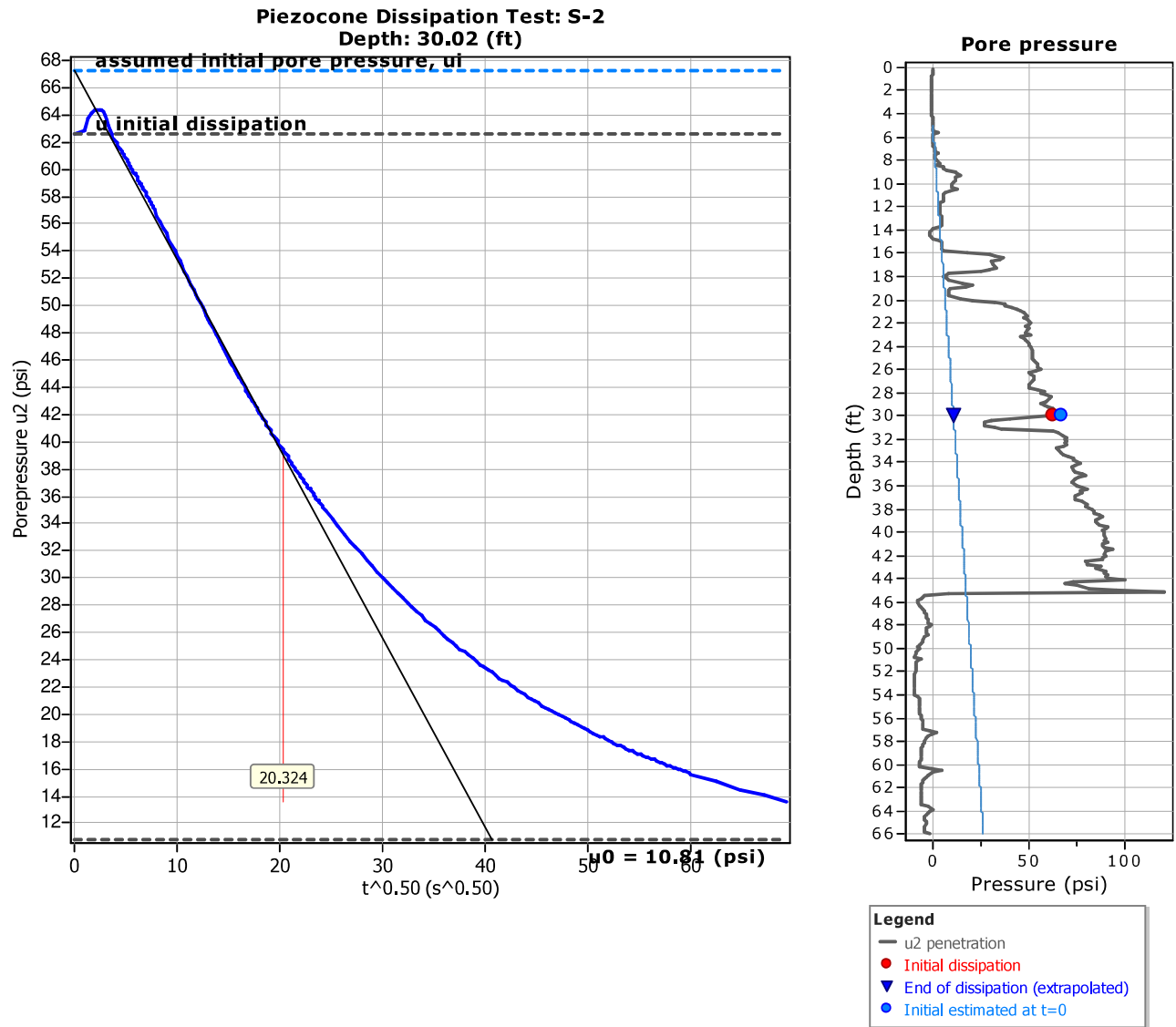
The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction (c_h) which is influenced by a combination of the soil permeability (k_h) and compressibility (M), as defined by the following:


$$k_h = c_h \times \gamma_w / M$$

where: M is the 1-D constrained modulus and γ_w is the unit weight of water, in compatible units.

Tabular results

CPTU Borehole	Depth (ft)	$(t_{50})^{0.50}$	t_{50} (s)	t_{50} (years)	G/ S_u	c_h (ft ² /s)	c_h (ft ² /year)	M (tsf)	k_h (ft/s)
S-2	30.02	20.3	413	1.31E-005	523337.06	1.44E-004	4532	46.46	9.66E-008



CLIENT: MBF Architects PA	PROJECT NO.: 22:32370	SHEET: 1 of 1	
PROJECT NAME: P1594 RR1 Replacement	HAND AUGER NO.: C-01	SURFACE ELEVATION:	
SITE LOCATION: Powder Lane, Sneads Ferry, North Carolina, 28445		STATION:	
NORTHING:	EASTING:		

DEPTH (FT)	WATER LEVELS	ELEVATION (FT)	DESCRIPTION OF MATERIAL	EXCAVATION EFFORT	DCP	SAMPLE NUMBER	FINES CONTENT (%)	MOISTURE CONTENT (%)
			Asphalt Thickness[3.50"]					
			ABC Stone Thickness[14.00"]					
			(SP) FINE TO MEDIUM SAND, white, moist					
			(SM) SILTY FINE TO MEDIUM SAND, brown, moist					
			END OF HAND AUGER AT 4 FT					
5		-5						

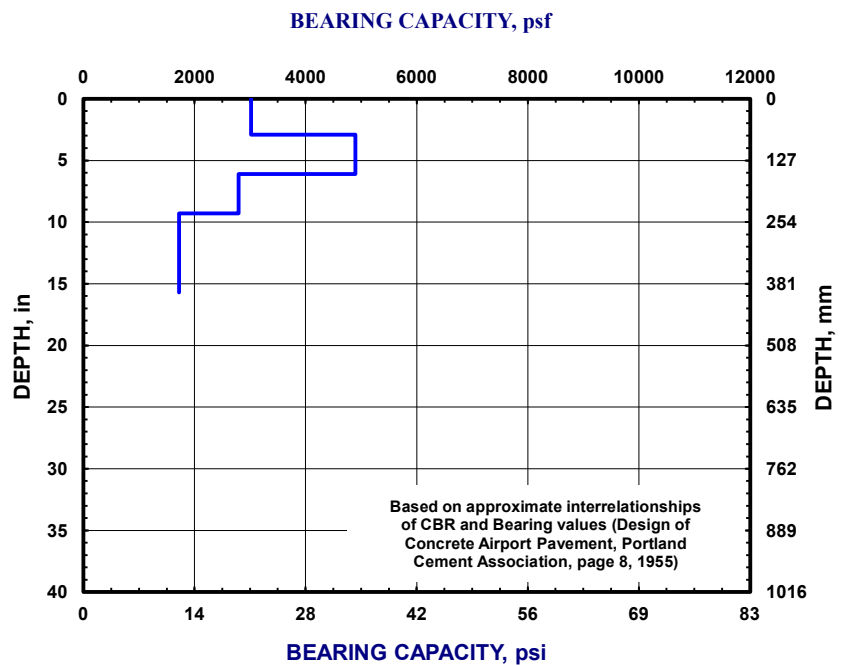
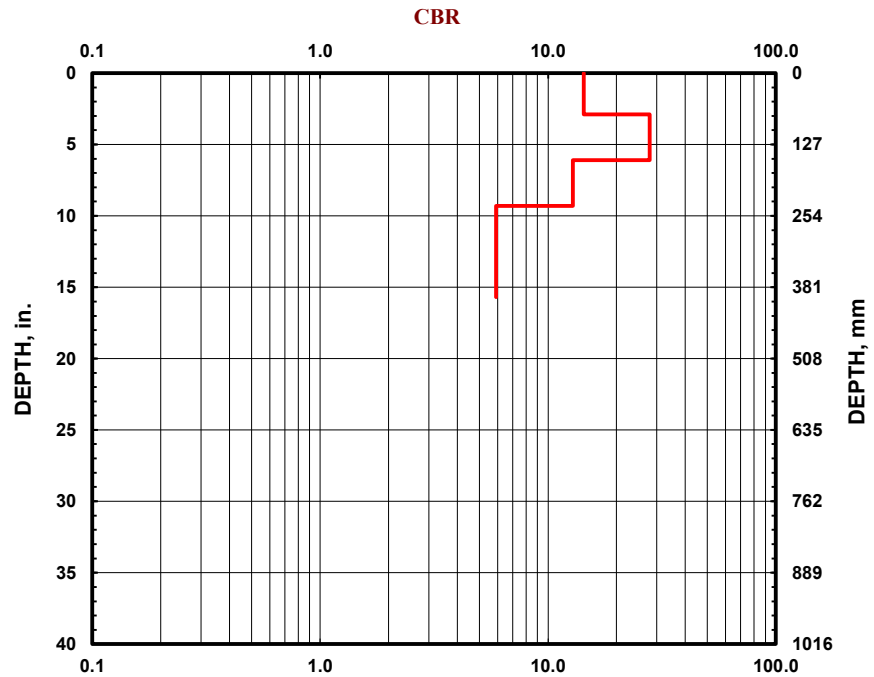
REMARKS:							
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDRY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL							
EXCAVATION EFFORT: E - EASY M - MEDIUM D - DIFFICULT VD - VERY DIFFICULT							
<input type="checkbox"/> WL (First Encountered)	<input checked="" type="checkbox"/> WL (Seasonal High)	ECS REP:	DATE COMPLETED:	UNITS:	CAVE-IN-DEPTH:		
<input checked="" type="checkbox"/> WL (Completion)		REG	Dec 19 2022	English			
HAND AUGER LOG							


DCP TEST DATA			
Project:	<u>P-1594 RR1</u>	Date:	<u>16-Dec-22</u>
Location:	<u>C-1</u>	Soil Type(s):	<u>SAND (SP/SM)</u>
Hammer <input type="radio"/> 10.1 lbs. <input checked="" type="radio"/> 17.6 lbs. <input type="radio"/> Both hammers used		Soil Type <input type="radio"/> CH <input type="radio"/> CL <input checked="" type="radio"/> All other soils	

Date: 16-Dec-22
Soil Type(s): SAND (SP/SM)

Soil Type

- ☐ CH
- ☐ CL
- ☒ All other soils

[illegible]

CLIENT: MBF Architects PA	PROJECT NO.: 22:32370	SHEET: 1 of 1	
PROJECT NAME: P1594 RR1 Replacement	HAND AUGER NO.: C-02	SURFACE ELEVATION:	
SITE LOCATION: Powder Lane, Sneads Ferry, North Carolina, 28445		STATION:	
NORTHING:	EASTING:		

DEPTH (FT)	WATER LEVELS	ELEVATION (FT)	DESCRIPTION OF MATERIAL	EXCAVATION EFFORT	DCP	SAMPLE NUMBER	FINES CONTENT (%)	MOISTURE CONTENT (%)
			Asphalt Thickness[4.00"]					
			ABC Stone Thickness[9.00"]					
			(SM) SILTY FINE TO MEDIUM SAND, brown/ tan, moist					
			(SP) FINE TO MEDIUM SAND, white/ orange, moist					
			END OF HAND AUGER AT 4 FT					
5		-5						

REMARKS:							
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL							
EXCAVATION EFFORT: E - EASY M - MEDIUM D - DIFFICULT VD - VERY DIFFICULT							
<input type="checkbox"/> WL (First Encountered)	<input checked="" type="checkbox"/> WL (Seasonal High)	ECS REP:	DATE COMPLETED:	UNITS:	CAVE-IN-DEPTH:		
<input checked="" type="checkbox"/> WL (Completion)		REG	Dec 19 2022	English			
HAND AUGER LOG							

DCP TEST DATA

Project: P-1594 RR1

Location:

Date: 16-Dec-22Soil Type(s): SAND (SP/SM)

Hammer

☐ 10.1 lbs.

☒ 17.6 lbs.

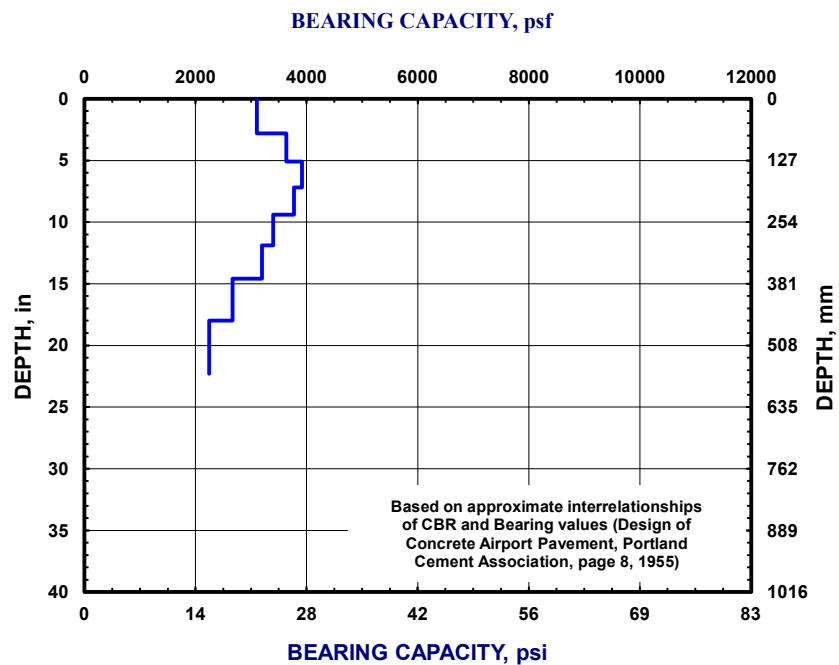
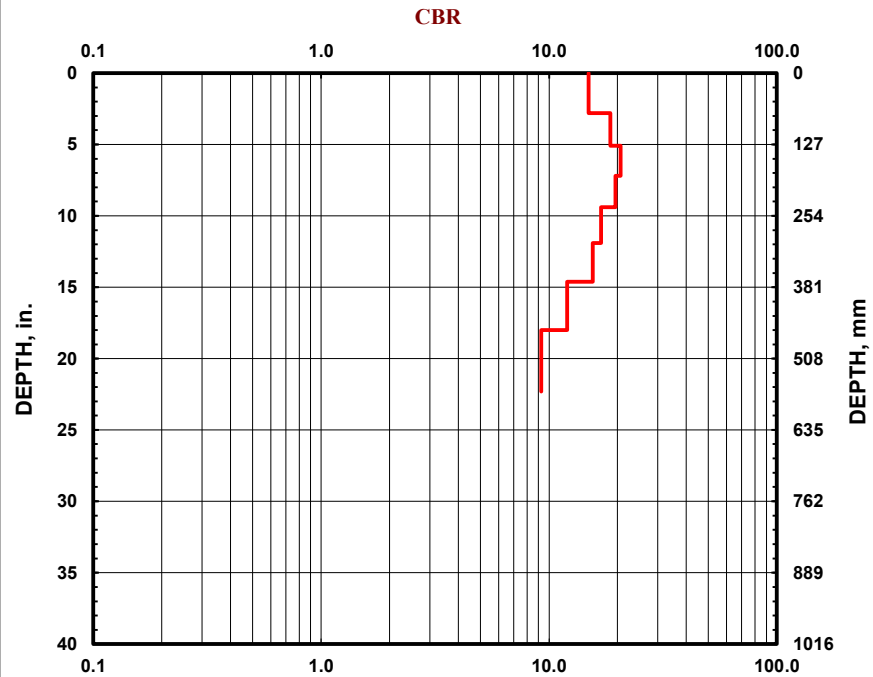
☐ Both hammers used

Soil Type

☐ CH

☐ CL

☒ All other soils

[illegible]

CLIENT: MBF Architects PA		PROJECT NO.: 22:32370		SHEET: 1 of 1	
PROJECT NAME: P1594 RR1 Replacement		HAND AUGER NO.: C-03		SURFACE ELEVATION:	
SITE LOCATION: Powder Lane, Sneads Ferry, North Carolina, 28445				STATION:	
NORTHING:		EASTING:			

DEPTH (FT)	WATER LEVELS	ELEVATION (FT)	DESCRIPTION OF MATERIAL	EXCAVATION EFFORT	DCP	SAMPLE NUMBER	FINES CONTENT (%)	MOISTURE CONTENT (%)
			Asphalt Thickness[6.00"]					
			ABC Stone Thickness[8.00"]					
			(SM) SILTY FINE TO MEDIUM SAND, brown/ tan, moist					
			END OF HAND AUGER AT 4 FT					
5		-5						

REMARKS:

 THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL
 EXCAVATION EFFORT: E - EASY M - MEDIUM D - DIFFICULT VD - VERY DIFFICULT

▽ WL (First Encountered)	▼ WL (Seasonal High)	ECS REP:	DATE COMPLETED:	UNITS:	CAVE-IN-DEPTH:
▼ WL (Completion)		REG	Dec 19 2022	English	

HAND AUGER LOG

DCP TEST DATA

Project: P-1594 RR1

Location:

Date: 16-Dec-22Soil Type(s): SAND (SM)

Hammer

☐ 10.1 lbs.

☒ 17.6 lbs.

☐ Both hammers used

Soil Type

☐ CH

☐ CL

☒ All other soils

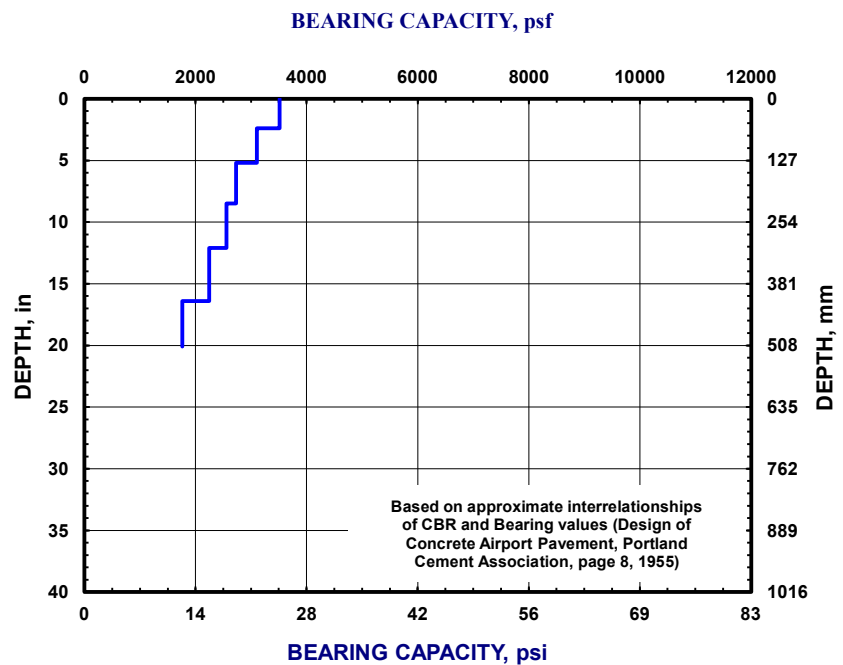
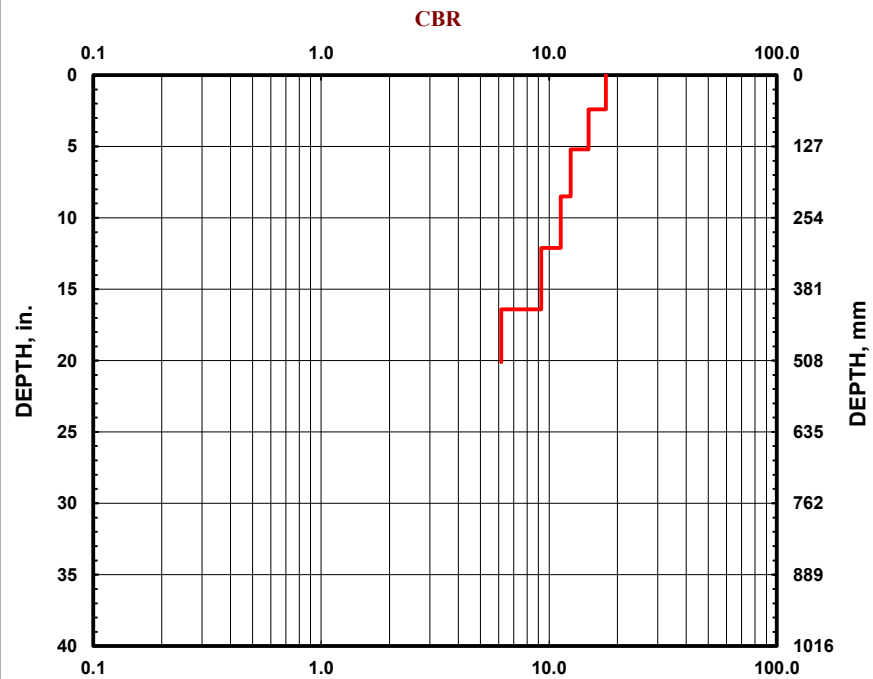
[illegible]



Figure 1: Asphalt Core C-1



Figure 2: Asphalt Core C-2

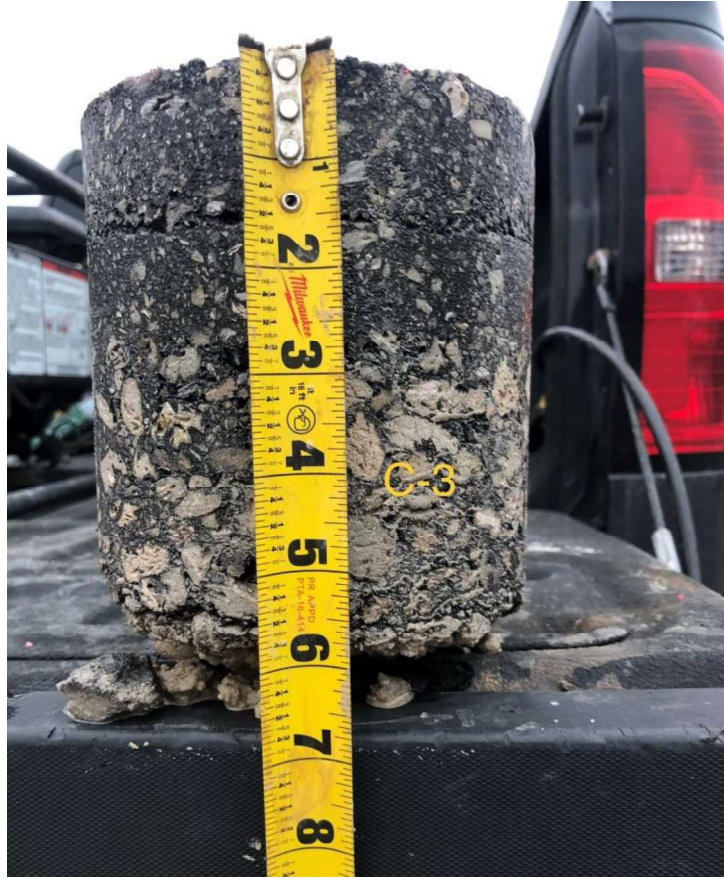


Figure 3: Asphalt Core C-3

APPENDIX C – Laboratory Testing

Laboratory Test Results Summary

Atterberg Limit Tests

Grain Size Analyses Results

Laboratory Testing Summary

Sample Location	Sample Number	Depth (feet)	^MC (%)	Soil Type	Atterberg Limits			**Percent Passing No. 200 Sieve	Moisture - Density		CBR (%)		#Organic Content (%)
					LL	PL	PI		<Maximum Density (pcf)	<Optimum Moisture (%)	0.1 in.	0.2 in.	
B-01	S-5	8-10	43.5	SP-SM	NP	NP	NP	13.9					
B-01	S-7	13-15	26.5	SP	NP	NP	NP	2.6					
B-01	S-8	18-20	26.7	SM	NP	NP	NP	27.5					
B-01	S-11	33-35	39.5	ML	32	28	4	69.6					
B-01	S-12	38-40	36.5	CL	31	22	9	75.7					
B-01	S-16	58-60	24.9	ML	NP	NP	NP	60.4					
B-02	S-3	4-6	18.5	SP	NP	NP	NP	3.2					
B-02	S-7	13-15	33.7	SM	NP	NP	NP	29.7					

Notes: See test reports for test method, ^ASTM D2216-19, *ASTM D2488, **ASTM D1140-17, #ASTM D2974-20e1 < See test report for D4718 corrected values

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content

Project: P1594 RR1 Replacement
Client: MBF Architects PA

Project No.: 22-32370
Date Reported: 1/23/2023



Office / Lab

Address

Office Number / Fax

ECS Southeast LLP - Wilmington

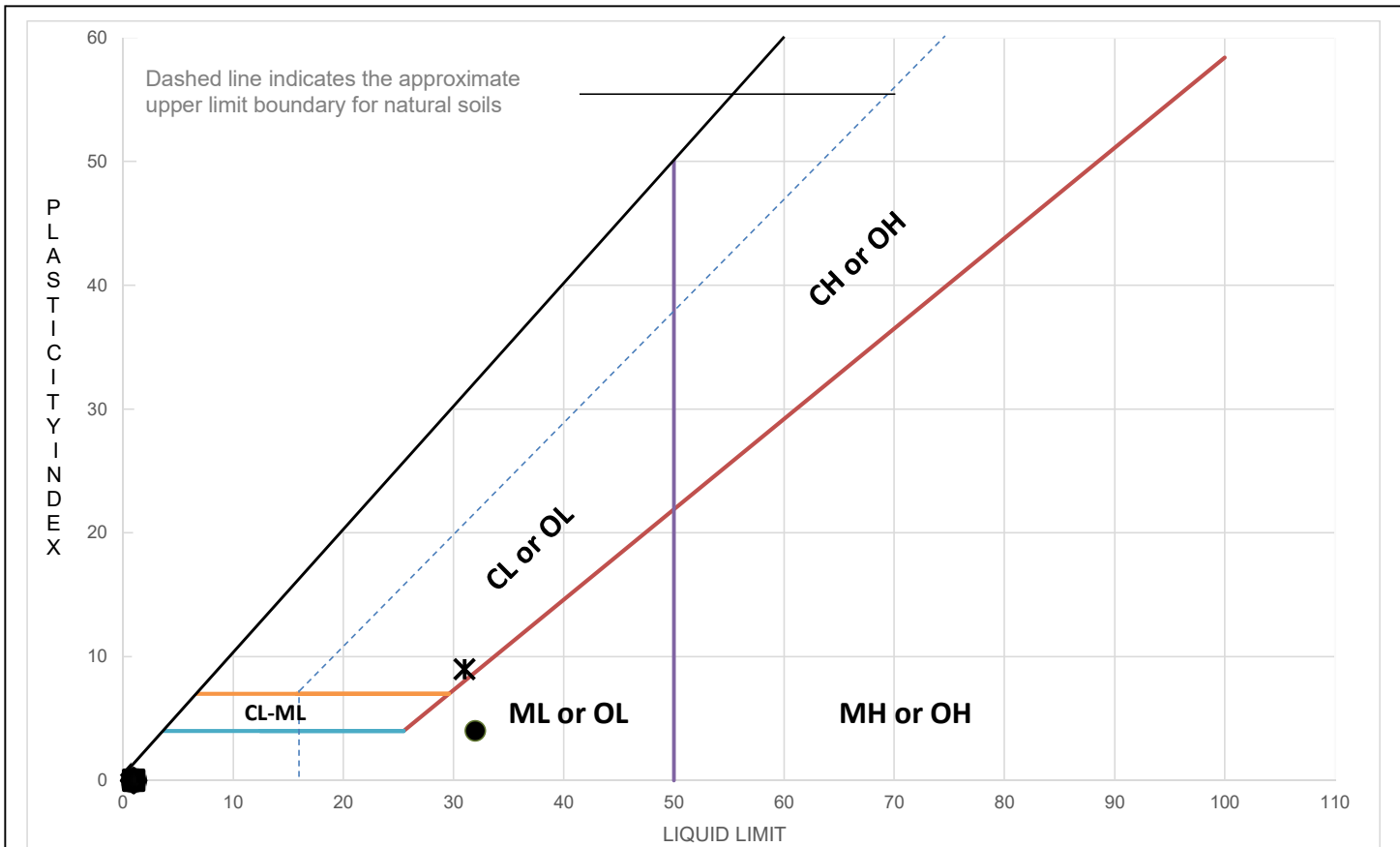
6714 Netherlands Drive
Wilmington, NC 28405

(910)686-9114

(910)686-9666

Tested by	Checked by	Approved by	Date Received
		MYong1	12/12/2022

LIQUID AND PLASTIC LIMITS TEST REPORT



TEST RESULTS (ASTM D4318-10 (MULTIPOINT TEST))

	Sample Location	Sample Number	Sample Depth (ft)	LL	PL	PI	%<#40	%<#200	AASHTO	USCS	Material Description
■	B-01	S-5	8-10	NP	NP	NP	98.2	13.9		SP-SM	brown sand with silt
◆	B-01	S-7	13-15	NP	NP	NP	96.6	2.6		SP	brown sand
▲	B-01	S-8	18-20	NP	NP	NP	99.6	27.5		SM	gray silty sand
●	B-01	S-11	33-35	32	28	4	99.9	69.6		ML	silty sand
*	B-01	S-12	38-40	31	22	9	100.0	75.7		CL	gray sandy clay
⊗	B-01	S-16	58-60	NP	NP	NP	98.7	60.4		ML	gray sandy silt
□	B-02	S-3	4-6	NP	NP	NP	96.7	32.7		SP	brown sand
◇	B-02	S-7	13-15	NP	NP	NP	95.6	29.7		SM	brown silty sand

Project: P1594 RR1 Replacement
Client: MBF Architects PA

Project No.: 22:32370
Date Reported: 1/13/2023



Office / Lab

ECS Southeast LLP - Wilmington

Address

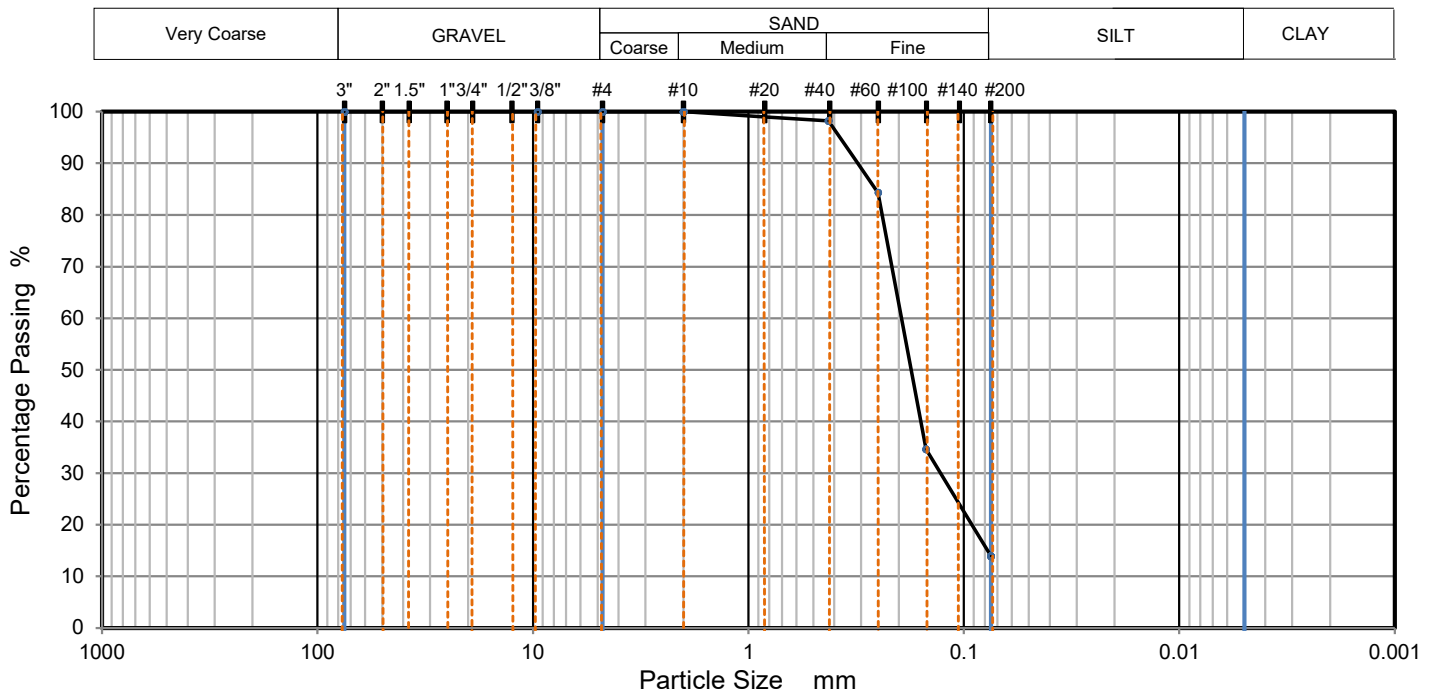
6714 Netherlands Drive
Wilmington, NC 28405

Office Number / Fax

(910)686-9114
(910)686-9666

Tested by	Checked by	Approved by	Date Received
		MYoung1	12/12/2022

PARTICLE SIZE DISTRIBUTION



TEST RESULTS (ASTM D6913M-17-METHOD A)

Sieving		Hydrometer Sedimentation	
Particle Size	% Passing	Particle Size mm	% Passing
3"	100		
3/8"	100		
#4	100		
#10	100		
#40	98		
#60	84		
#100	35		
#200	14		

Dry Mass of sample, g

165.1

Sample Proportions	% dry mass
Very coarse, >3" sieve	0
Gravel, 3" to # 4 sieve	0
Coarse Sand, #4 to #10 sieve	0
Medium Sand, #10 to #40	2
Fine Sand, #40 to #200	84
Fines <#200	14

USCS	SP-SM	Liquid Limit	NP	D90	0.311	D50	0.176	D10	
AASHTO	A-2-4	Plastic Limit	NP	D85	0.257	D30	0.129	Cu	
USCS Group Name	Sand with silt	Plasticity Index	NP	D60	0.195	D15	0.078	Cc	

Project: P1594 RR1 Replacement

Client: MBF Architects PA

Sample Description: brown sand with silt

Sample Source: B-01

Project No.: 22:32370

Depth (ft): 8 - 10

Sample No.: S-5

Date Reported: 1/23/2023



Office / Lab

Address

Office Number / Fax

ECS Southeast LLP - Wilmington

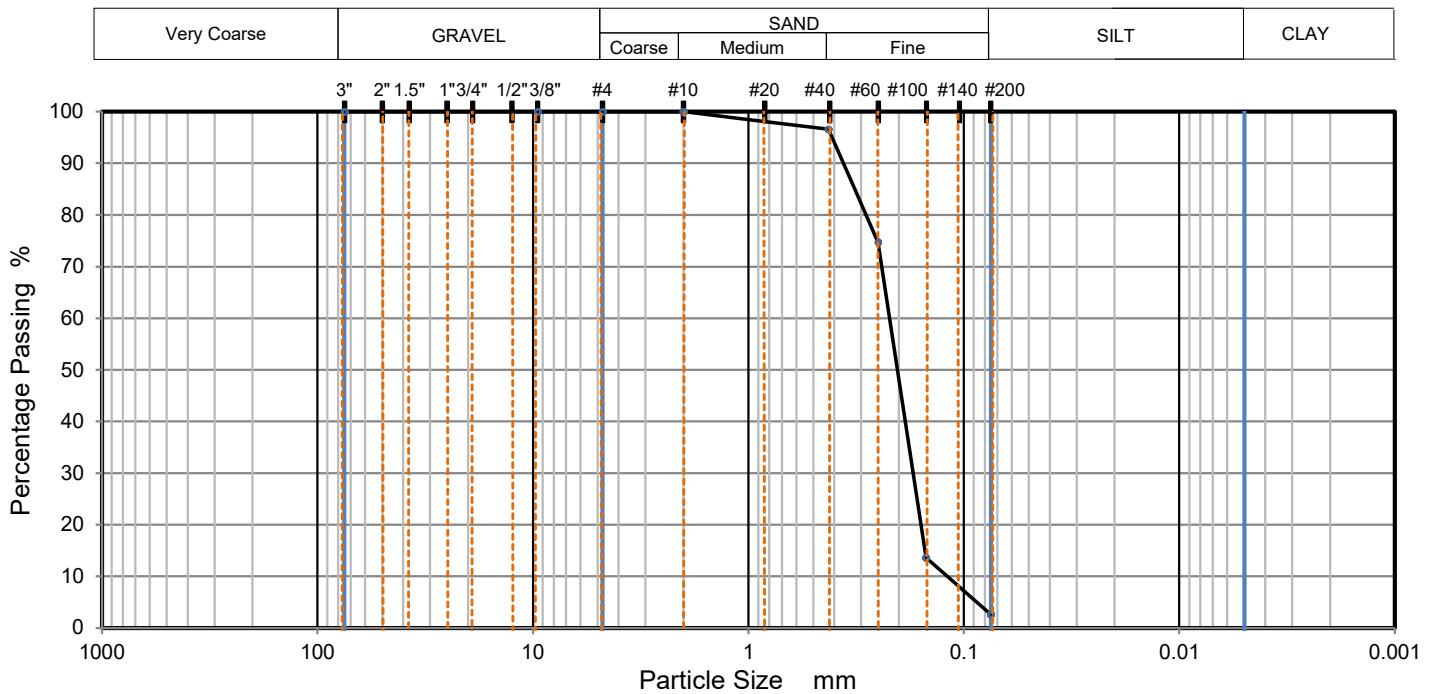
6714 Netherlands Drive
Wilmington, NC 28405

(910)686-9114

(910)686-9666

Tested by	Checked by	Approved by	Date Received	Remarks
		MYoung1	12/12/2022	

PARTICLE SIZE DISTRIBUTION



TEST RESULTS (ASTM D6913M-17-METHOD A)

Sieving		Hydrometer Sedimentation	
Particle Size	% Passing	Particle Size mm	% Passing
3"	100		
3/8"	100		
#4	100		
#10	100		
#40	97		
#60	75		
#100	14		
#200	3		

Dry Mass of sample, g

220.5

Sample Proportions	% dry mass
Very coarse, >3" sieve	0
Gravel, 3" to # 4 sieve	0
Coarse Sand, #4 to #10 sieve	0
Medium Sand, #10 to #40	3
Fine Sand, #40 to #200	94
Fines <#200	3

USCS	SP	Liquid Limit	NP	D90	0.362	D50	0.203	D10	0.120
AASHTO	A-3	Plastic Limit	NP	D85	0.321	D30	0.172	Cu	1.849
USCS Group Name	Poorly graded sand	Plasticity Index	NP	D60	0.221	D15	0.152	Cc	1.119

Project: P1594 RR1 Replacement
 Client: MBF Architects PA
 Sample Description: brown sand
 Sample Source: B-01

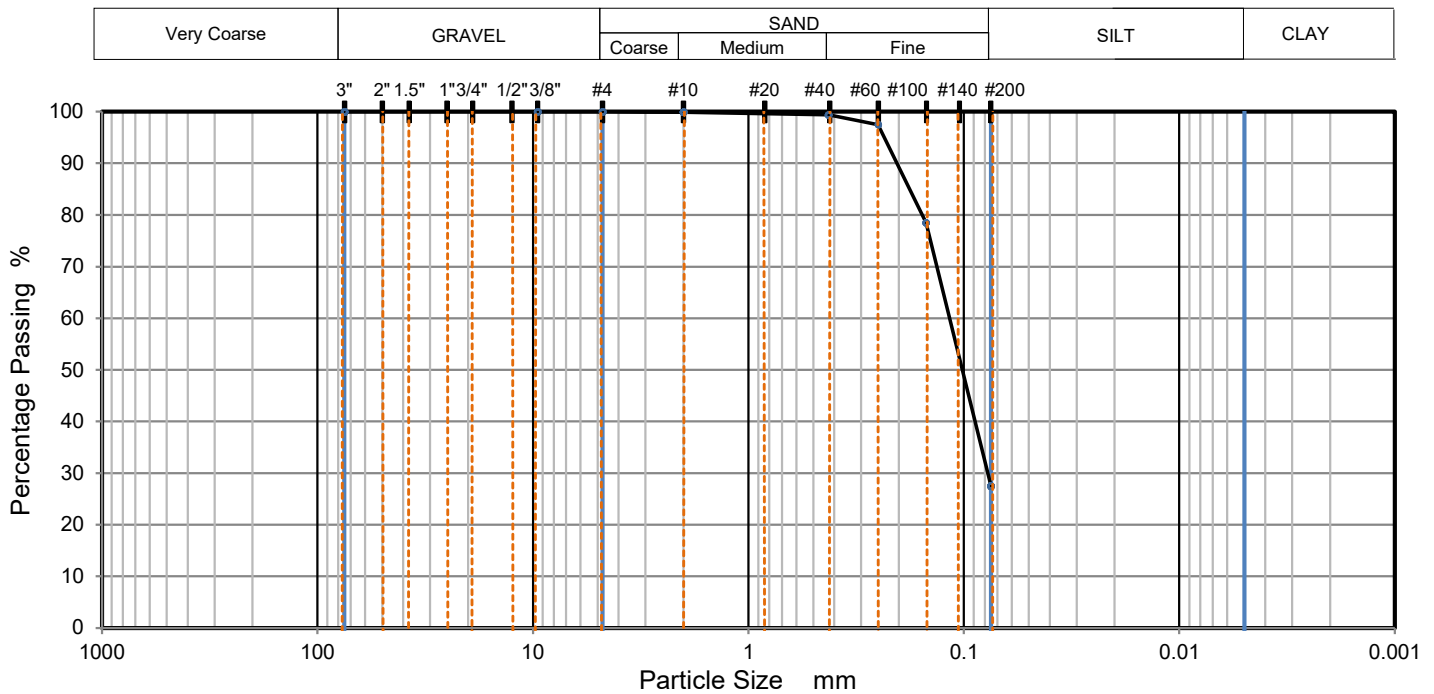
Project No.: 22:32370
 Depth (ft): 13 - 15
 Sample No.: S-7
 Date Reported: 1/23/2023



Office / Lab	Address	Office Number / Fax
ECS Southeast LLP - Wilmington	6714 Netherlands Drive Wilmington, NC 28405	(910)686-9114 (910)686-9666

Tested by	Checked by	Approved by	Date Received	Remarks
		MYoung1	12/12/2022	

PARTICLE SIZE DISTRIBUTION



TEST RESULTS (ASTM D6913M-17-METHOD A)

Sieving		Hydrometer Sedimentation	
Particle Size	% Passing	Particle Size mm	% Passing
3"	100		
3/8"	100		
#4	100		
#10	100		
#40	99		
#60	98		
#100	79		
#200	28		

Dry Mass of sample, g

216.4

Sample Proportions	% dry mass
Very coarse, >3" sieve	0
Gravel, 3" to # 4 sieve	0
Coarse Sand, #4 to #10 sieve	0
Medium Sand, #10 to #40	1
Fine Sand, #40 to #200	72
Fines <#200	28

USCS	SM	Liquid Limit	NP	D90	0.204	D50	0.102	D10	
AASHTO	A-2-4	Plastic Limit	NP	D85	0.179	D30	0.078	Cu	
USCS Group Name	Silty sand	Plasticity Index	NP	D60	0.117	D15		Cc	

Project: P1594 RR1 Replacement

Client: MBF Architects PA

Sample Description: gray silty sand

Sample Source: B-01

Project No.: 22:32370

Depth (ft): 18 - 20

Sample No.: S-8

Date Reported: 1/23/2023



Office / Lab

Address

Office Number / Fax

ECS Southeast LLP - Wilmington

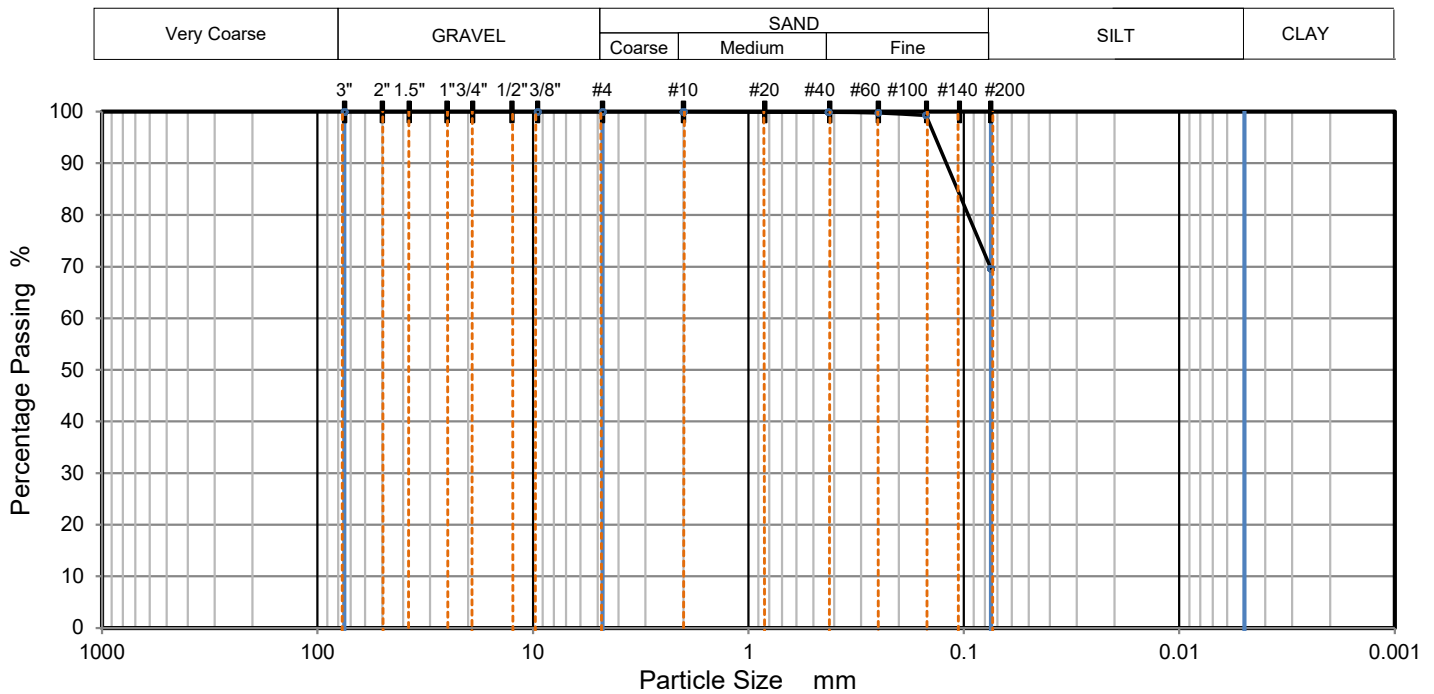
6714 Netherlands Drive
Wilmington, NC 28405

(910)686-9114

(910)686-9666

Tested by	Checked by	Approved by	Date Received	Remarks
		MYoung1	12/12/2022	

PARTICLE SIZE DISTRIBUTION



TEST RESULTS (ASTM D6913M-17-METHOD A)

Sieving		Hydrometer Sedimentation	
Particle Size	% Passing	Particle Size mm	% Passing
3"	100		
3/8"	100		
#4	100		
#10	100		
#40	100		
#60	100		
#100	99		
#200	70		

Dry Mass of sample, g

163.2

Sample Proportions	% dry mass
Very coarse, >3" sieve	0
Gravel, 3" to # 4 sieve	0
Coarse Sand, #4 to #10 sieve	0
Medium Sand, #10 to #40	0
Fine Sand, #40 to #200	30
Fines <#200	70

USCS	ML	Liquid Limit	32	D90	0.121	D50		D10	
AASHTO	A-4	Plastic Limit	28	D85	0.107	D30		Cu	
USCS Group Name	Sandy silt	Plasticity Index	4	D60		D15		Cc	

Project: P1594 RR1 Replacement

Client: MBF Architects PA

Sample Description: gray sandy silt

Sample Source: B-01

Project No.: 22:32370

Depth (ft): 33 - 35

Sample No.: S-11

Date Reported: 1/23/2023



Office / Lab

Address

Office Number / Fax

ECS Southeast LLP - Wilmington

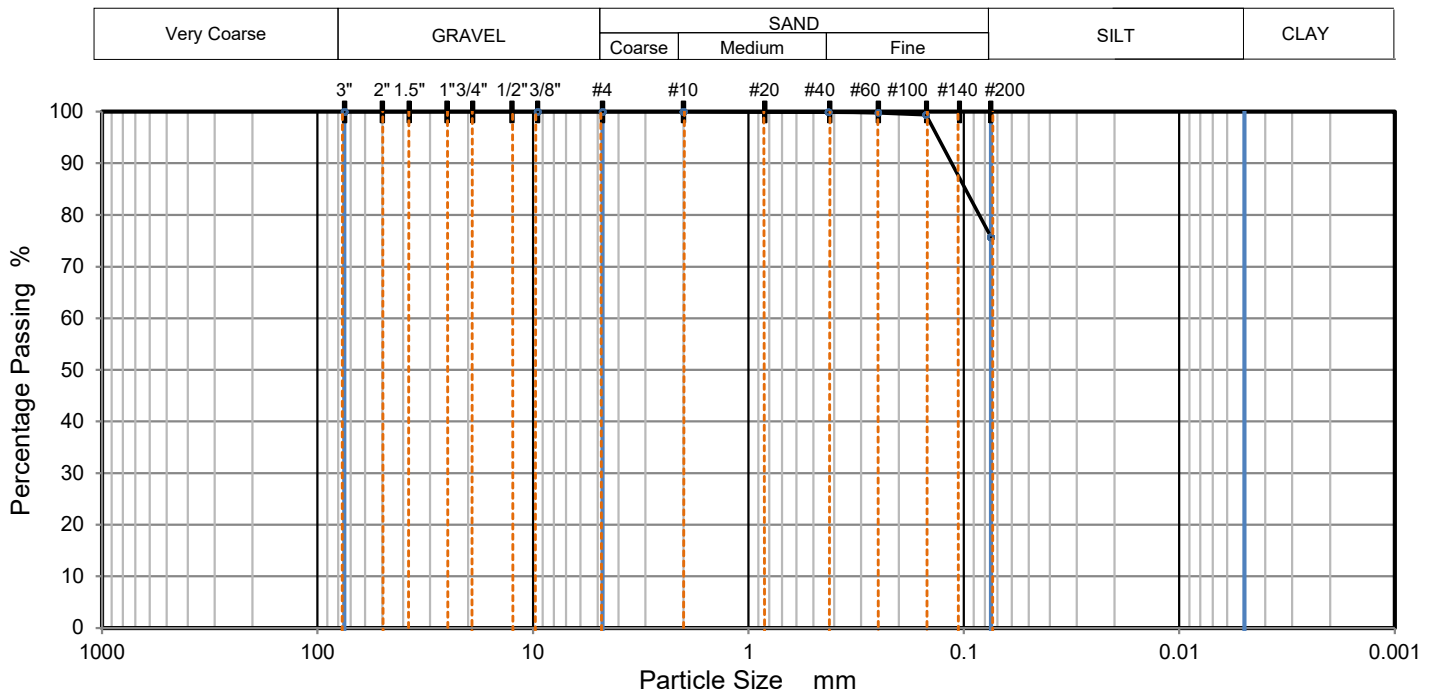
6714 Netherlands Drive
Wilmington, NC 28405

(910)686-9114

(910)686-9666

Tested by	Checked by	Approved by	Date Received	Remarks
		MYoung1	12/12/2022	

PARTICLE SIZE DISTRIBUTION



TEST RESULTS (ASTM D6913M-17-METHOD A)

Sieving		Hydrometer Sedimentation	
Particle Size	% Passing	Particle Size mm	% Passing
3"	100		
3/8"	100		
#4	100		
#10	100		
#40	100		
#60	100		
#100	99		
#200	76		

Dry Mass of sample, g

199.1

Sample Proportions	% dry mass
Very coarse, >3" sieve	0
Gravel, 3" to # 4 sieve	0
Coarse Sand, #4 to #10 sieve	0
Medium Sand, #10 to #40	0
Fine Sand, #40 to #200	24
Fines <#200	76

USCS	CL	Liquid Limit	31	D90	0.114	D50		D10	
AASHTO	A-4	Plastic Limit	22	D85	0.098	D30		Cu	
USCS Group Name	Lean clay with sand	Plasticity Index	9	D60		D15		Cc	

Project: P1594 RR1 Replacement

Client: MBF Architects PA

Sample Description: gray sandy clay

Sample Source: B-01

Project No.: 22:32370

Depth (ft): 38 - 40

Sample No.: S-12

Date Reported: 1/23/2023



Office / Lab

Address

Office Number / Fax

ECS Southeast LLP - Wilmington

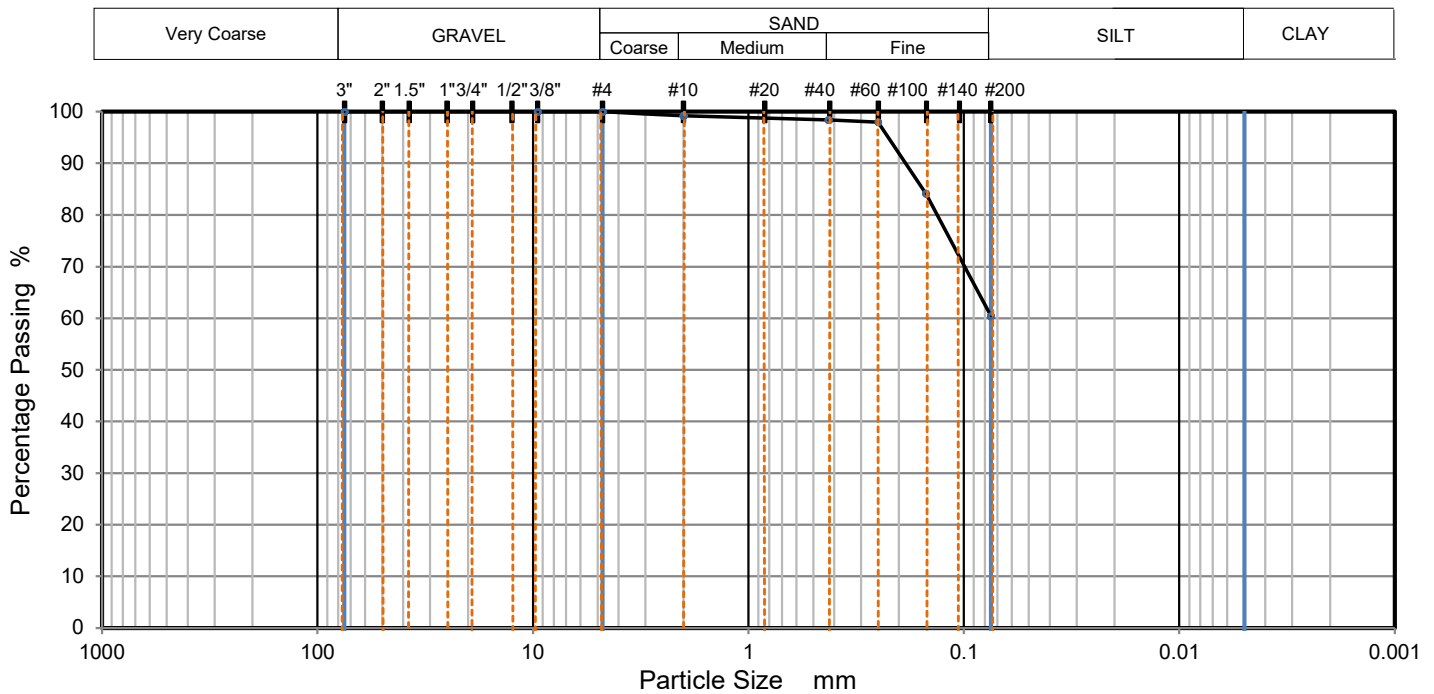
6714 Netherlands Drive
Wilmington, NC 28405

(910)686-9114

(910)686-9666

Tested by	Checked by	Approved by	Date Received	Remarks
		MYoung1	12/12/2022	

PARTICLE SIZE DISTRIBUTION



TEST RESULTS (ASTM D6913M-17-METHOD A)

Sieving		Hydrometer Sedimentation	
Particle Size	% Passing	Particle Size mm	% Passing
3"	100		
3/8"	100		
#4	100		
#10	99		
#40	98		
#60	98		
#100	84		
#200	60		

Dry Mass of sample, g

195.0

Sample Proportions	% dry mass
Very coarse, >3" sieve	0
Gravel, 3" to # 4 sieve	0
Coarse Sand, #4 to #10 sieve	1
Medium Sand, #10 to #40	1
Fine Sand, #40 to #200	38
Fines <#200	60

USCS	ML	Liquid Limit	NP	D90	0.186	D50		D10	
AASHTO	A-4	Plastic Limit	NP	D85	0.155	D30		Cu	
USCS Group Name	Sandy silt	Plasticity Index	NP	D60		D15		Cc	

Project: P1594 RR1 Replacement

Client: MBF Architects PA

Sample Description: gray sandy silt

Sample Source: B-01

Project No.: 22:32370

Depth (ft): 58 - 60

Sample No.: S-16

Date Reported: 1/23/2023



Office / Lab

Address

Office Number / Fax

ECS Southeast LLP - Wilmington

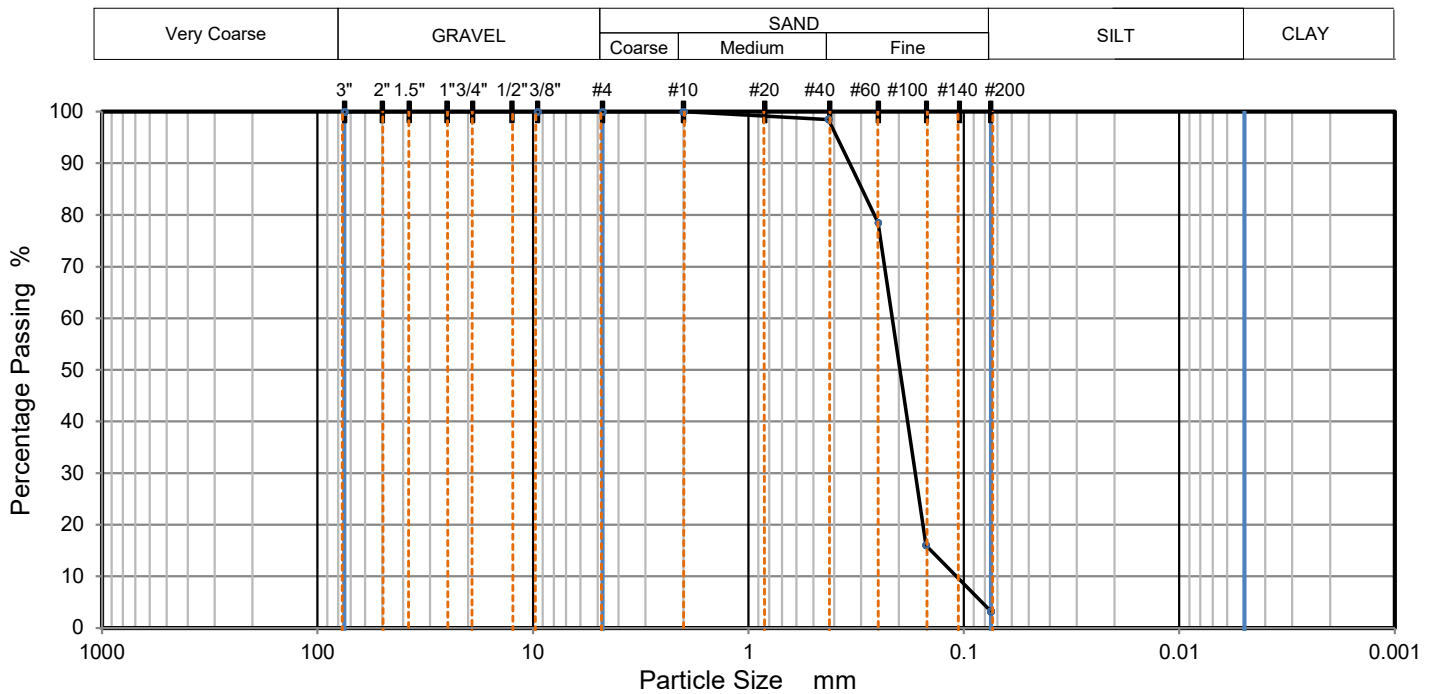
6714 Netherlands Drive
Wilmington, NC 28405

(910)686-9114

(910)686-9666

Tested by	Checked by	Approved by	Date Received	Remarks
		MYoung1	12/12/2022	

PARTICLE SIZE DISTRIBUTION



TEST RESULTS (ASTM D6913M-17-METHOD A)

Sieving		Hydrometer Sedimentation	
Particle Size	% Passing	Particle Size mm	% Passing
3"	100		
3/8"	100		
#4	100		
#10	100		
#40	99		
#60	79		
#100	16		
#200	3		

Dry Mass of sample, g

246.2

Sample Proportions	% dry mass
Very coarse, >3" sieve	0
Gravel, 3" to # 4 sieve	0
Coarse Sand, #4 to #10 sieve	0
Medium Sand, #10 to #40	2
Fine Sand, #40 to #200	95
Fines <#200	3

USCS	SP	Liquid Limit	NP	D90	0.339	D50	0.198	D10	0.108
AASHTO	A-3	Plastic Limit	NP	D85	0.297	D30	0.168	Cu	1.982
USCS Group Name	Poorly graded sand	Plasticity Index	NP	D60	0.215	D15	0.142	Cc	1.214

Project: P1594 RR1 Replacement
 Client: MBF Architects PA
 Sample Description: brown sand
 Sample Source: B-02

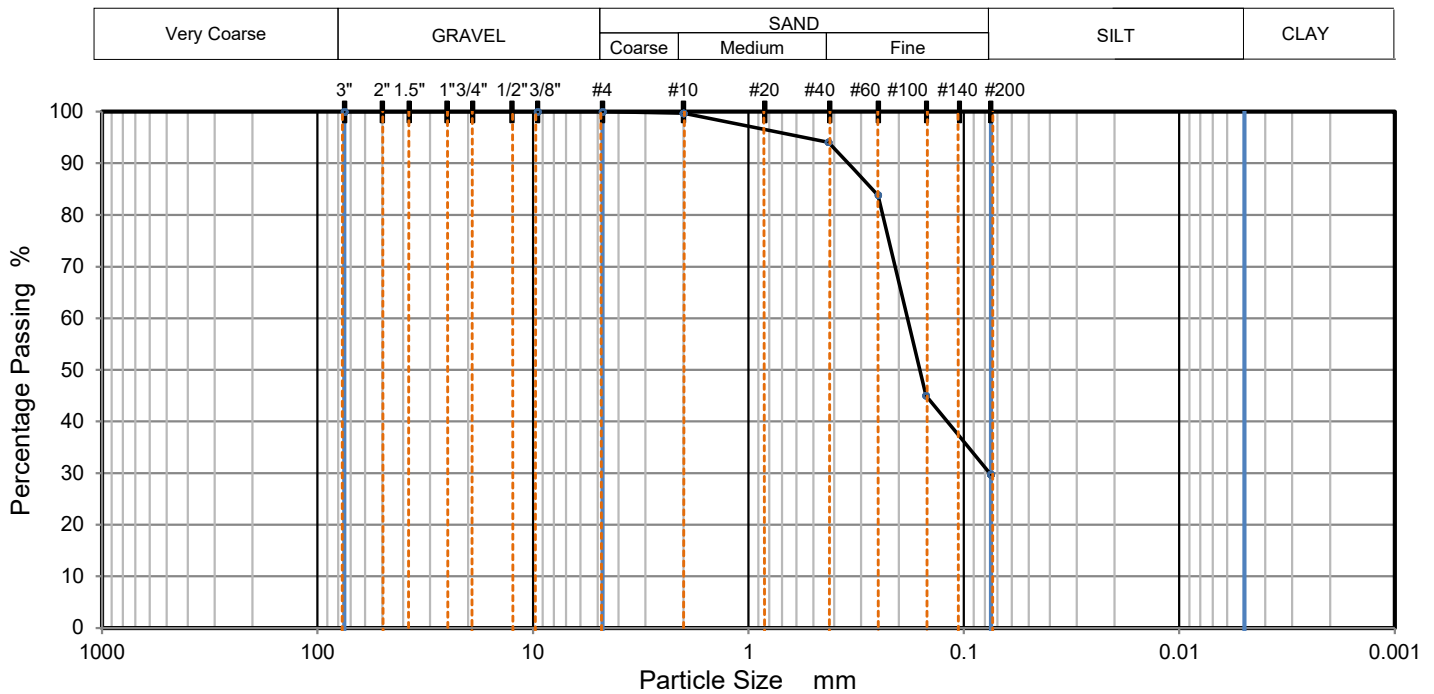
Project No.: 22:32370
 Depth (ft): 4 - 6
 Sample No.: S-3
 Date Reported: 1/23/2023



Office / Lab	Address	Office Number / Fax
ECS Southeast LLP - Wilmington	6714 Netherlands Drive Wilmington, NC 28405	(910)686-9114 (910)686-9666

Tested by	Checked by	Approved by	Date Received	Remarks
		MYoung1	12/12/2022	

PARTICLE SIZE DISTRIBUTION



TEST RESULTS (ASTM D6913M-17-METHOD A)

Sieving		Hydrometer Sedimentation	
Particle Size	% Passing	Particle Size mm	% Passing
3"	100		
3/8"	100		
#4	100		
#10	100		
#40	94		
#60	84		
#100	45		
#200	30		

Dry Mass of sample, g

177.7

Sample Proportions	% dry mass
Very coarse, >3" sieve	0
Gravel, 3" to # 4 sieve	0
Coarse Sand, #4 to #10 sieve	0
Medium Sand, #10 to #40	6
Fine Sand, #40 to #200	64
Fines <#200	30

USCS	SM	Liquid Limit	NP	D90	0.344	D50	0.160	D10	
AASHTO	A-2-4	Plastic Limit	NP	D85	0.266	D30	0.076	Cu	
USCS Group Name	Silty sand	Plasticity Index	NP	D60	0.183	D15		Cc	

Project: P1594 RR1 Replacement

Client: MBF Architects PA

Sample Description: brown silty sand

Sample Source: B-02

Project No.: 22:32370

Depth (ft): 13 - 15

Sample No.: S-7

Date Reported: 1/23/2023



Office / Lab

Address

Office Number / Fax

ECS Southeast LLP - Wilmington

6714 Netherlands Drive
Wilmington, NC 28405

(910)686-9114

(910)686-9666

Tested by	Checked by	Approved by	Date Received	Remarks
		MYoung1	12/12/2022	

APPENDIX D – Historical Information

Historical Aerial Imagery

Historical Topographic Maps



Figure 1: March 1993



Figure 2: July 2002

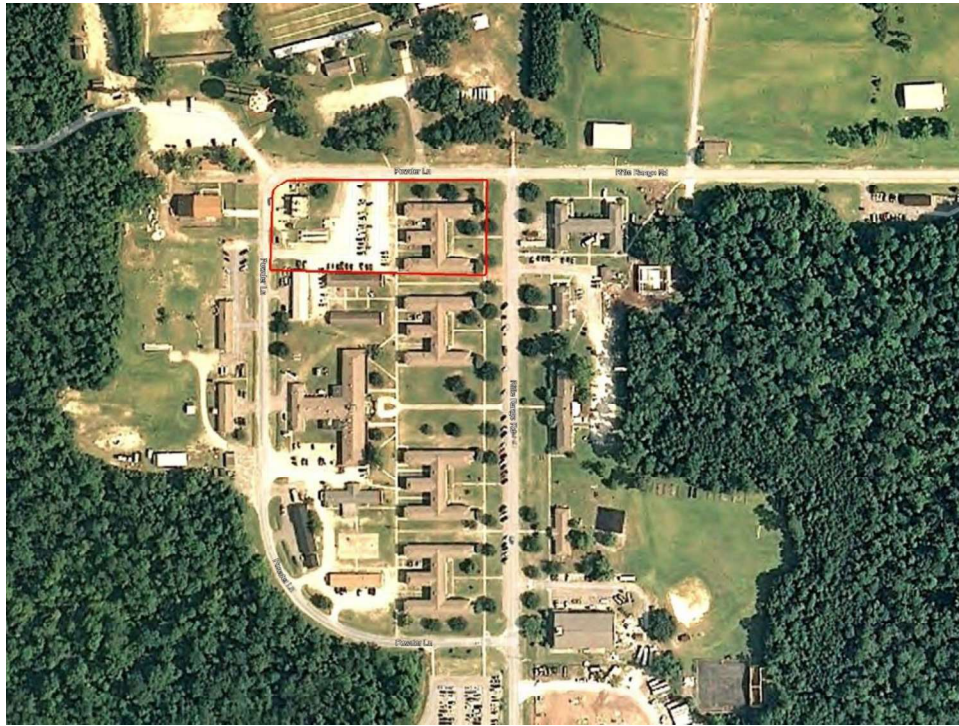


Figure 3: October 2008



Figure 4: December 2011



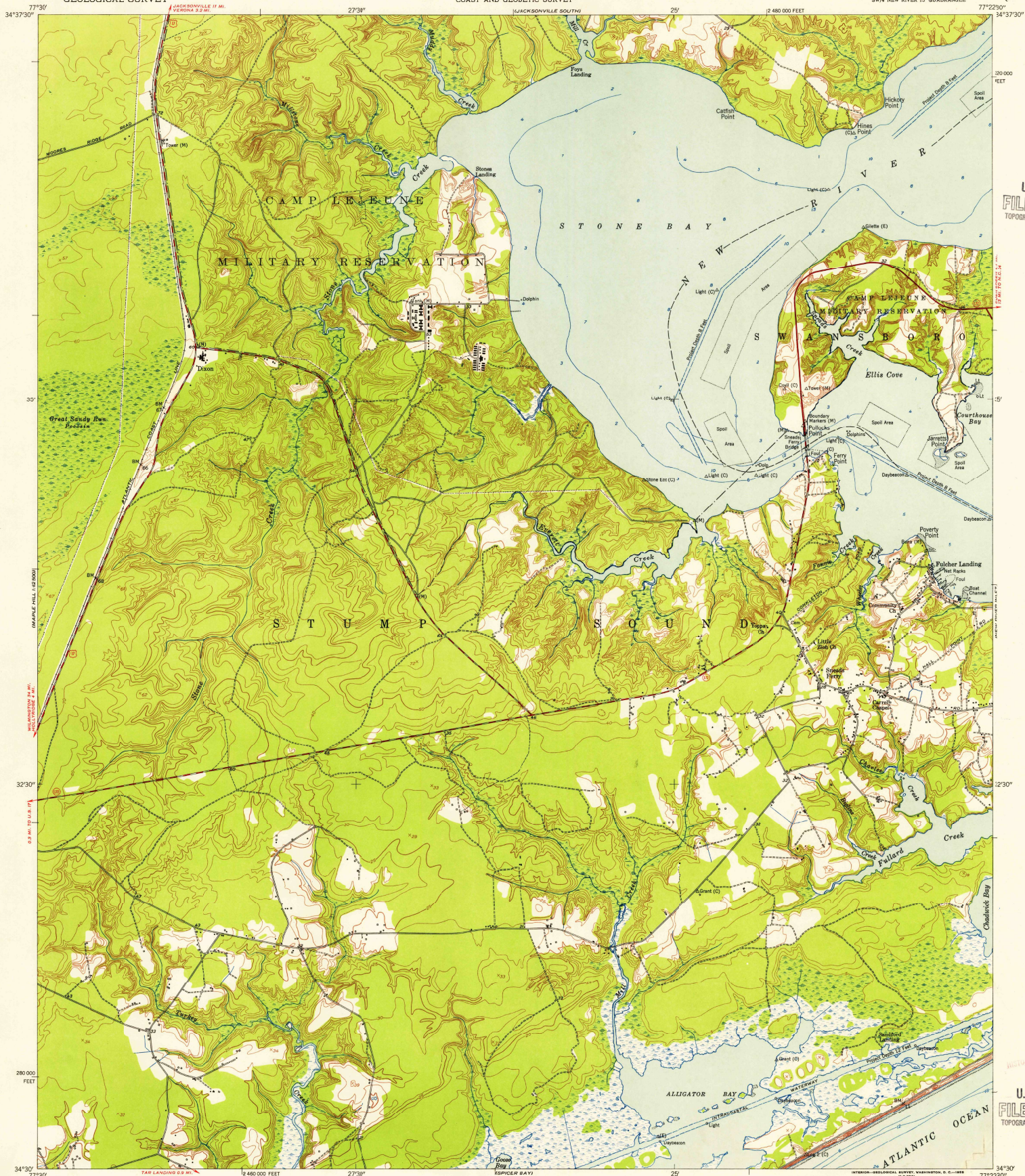
Figure 5: April 2014



Figure 6: September 2018

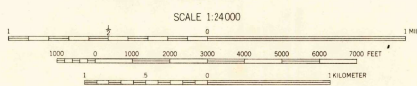


Figure 7: June 2019



Mapped by the U. S. Coast and Geodetic Survey
Edited and published by the Geological Survey
Control by USCGS (C), USCE (E), and USMC (M)
Culture and drainage in part compiled from aerial
photographs taken 1949 and 1952. Topography by
plane-table surveys 1950 and 1952. Field check 1952
Hydrography from surveys dated 1927 and 1933
Polyconic projection. 1927 North American datum
10,000-foot grid based on North Carolina coordinate
system
Unchecked elevations are shown in brown

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN
DECLINATION, 1952



CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS 3 FEET
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST



USGS
Topographic Division

SNEADS FERRY, N. C.
SW/4 NEW RIVER 15' QUADRANGLE
N3430—W7722.5/7.5
1952

USGS Library
Reston, VA
Topo Archive

SEP 13 1995

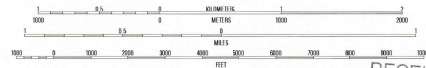
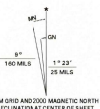


U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

SNEADS FERRY QUADRANGLE
NORTH CAROLINA-ONSLOW CO.
7.5-MINUTE SERIES (TOPOGRAPHIC)



Produced by the United States Geological Survey
Topography compiled by plane-table surveys, 1959 and 1962.
Planimetry derived from imagery taken 1957 and other sources.
Survey control current as of 1952.
North American Datum of 1983 (NAD 83). Projection and
1:50,000-meter grid. Universal Transverse Mercator, zone 18.
2,500-meter ticks. North Carolina Coordinate System of 1983.
North American Datum of 1927 (NAD 27) is shown by dashed
corner ticks. The values of the shift between NAD 83 and
NAD 27 for 7.5-minute intersections are obtainable from
National Geographic Survey (NADCON) software.
There may be private inholdings within the boundaries of the
National or State reservations shown on this map.



CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048
DEPTH CURVES AND SOUNDINGS IN FEET - DATUM IS MEAN LOW WATER
THE REFERENCE OF THE TIDE STAGE

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, P.O. BOX 25286, DENVER, COLORADO 80225
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

RECEIVED
AUG 31 2000
USGS
HISTORICAL MAP ARCHIVES



QUADRANGLE LOCATION			
1	2	3	1 New River
			2 southeastern South
			3 Camp Lejeune
			4 Folly
			5 New River
			6 Folly
			7 Spring Bay
			8

ROAD CLASSIFICATION
Primary highway
Light duty road, hard or
improved surface
Secondary highway
Unimproved road
Interstate Route
U.S. Route
State Route

SNEADS FERRY, NC
1997
NIMA 5053 01 5W 68BIS V42





U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

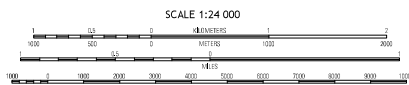
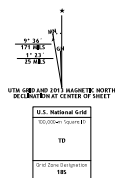


SNEADS FERRY QUADRANGLE
NORTH CAROLINA-ONSLOW CO.
7.5-MINUTE SERIES



Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
North American Datum of 1983 (NAD83)
North American Datum of 1983 (NAD83)
North American Datum of 1983 (NAD83)

Imagery: NAD83, May 2012
Roads: 2006-2012 TomTom
Hydrography: National Hydrography Dataset, 2012
Boundaries: Census, BGC, USGS, 1972-2012



SCALE 1:24 000
CONTOUR INTERVAL 5 FEET
NORTH AMERICAN VERTICAL DATUM OF 1983
This map was produced to conform with the
National Geospatial Program US Topo Product Standard, 2011.
A metadata file associated with this product is draft version S.6.11



Quadrangle	Scale	Color
Blaine	1:24,000	Blue
Shelby	1:24,000	Blue
Curran	1:24,000	Blue
Shelby	1:24,000	Blue
Shelby	1:24,000	Blue
Shelby	1:24,000	Blue
Shelby	1:24,000	Blue
Shelby	1:24,000	Blue

ROAD CLASSIFICATION
Expressway
Secondary Road
Ramp
Interstate Route
Local Connector
Local Road
4WD
US Route
State Route

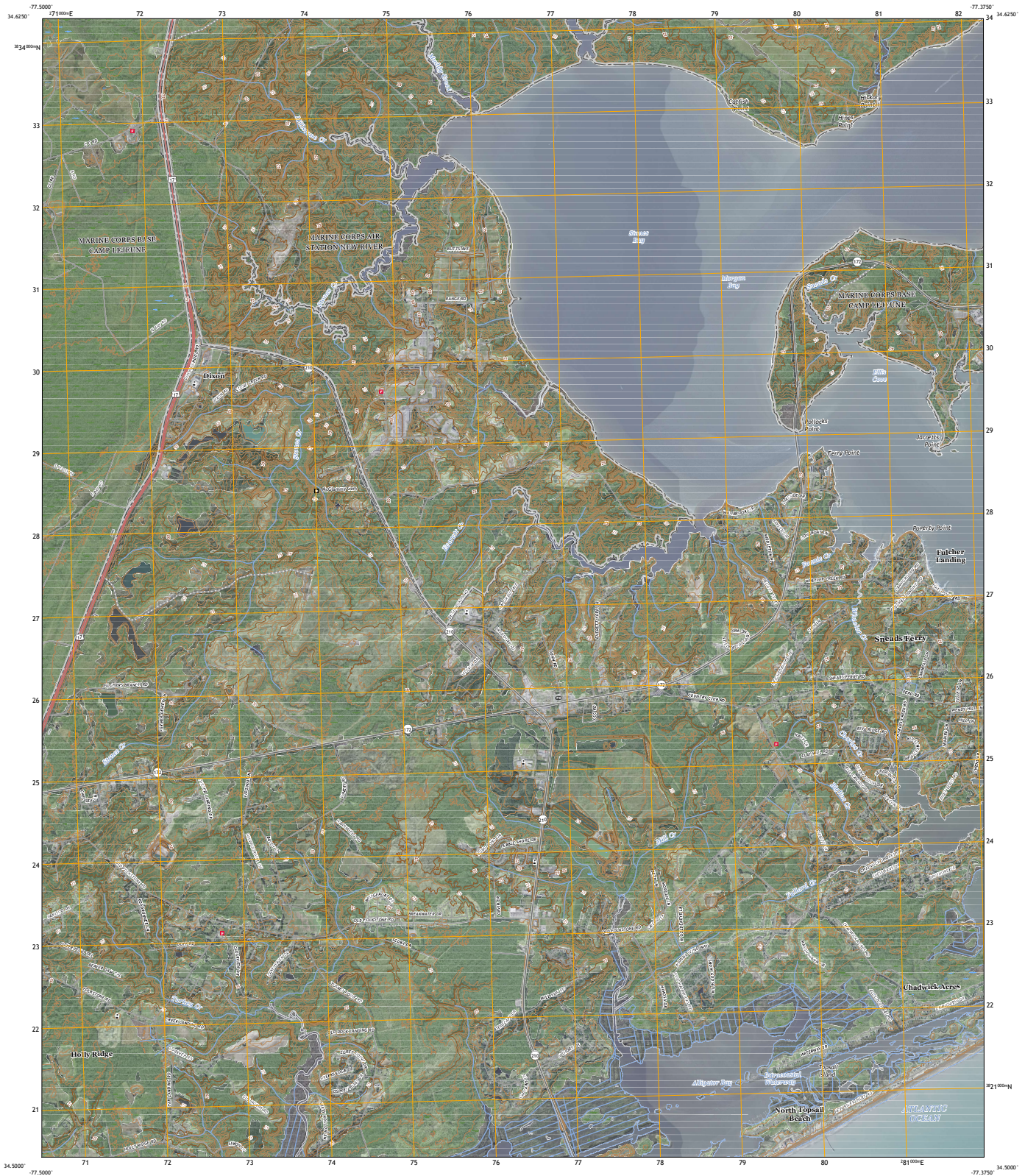
SNEADS FERRY, NC
2013



U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

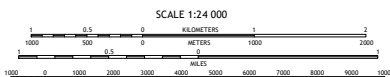
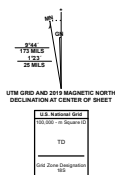


SNEADS FERRY QUADRANGLE
NORTH CAROLINA - ONSLOW COUNTY
7.5-MINUTE SERIES



Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84) Projection and
1 000-meter grid Universal Transverse Mercator, Zone 18S
This map is not a legal document. Boundaries may be
generalized for this map scale. Private lands within government
reservations may not be shown. Obtain permission before
entering private lands.

Imagery	NIP, September 2020 - September 2020
Roads	U.S. Census Bureau, 2016
Names	U.S. Census Bureau, 2022
Hydrography	National Hydrography Dataset, 2016
Contours	National Elevation Dataset, 2015
Boundaries	Multiple sources; see metadata file 2015 - 2021
Wetlands	FWS National Wetlands Inventory Not Available



CONTOUR INTERVAL: 5 FEET
NORTH AMERICAN DATUM OF 1983
This map was produced in conformance with the
National Geospatial Program US Topo Product Standard.



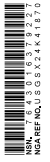
1	2	3
4	5	6
7	8	9

Adjacent quadrangles

- 1 Hanes Run
- 2 Jacksonville South
- 3 Camp Lejeune
- 4 Follyton
- 5 New River Inlet
- 6 Holly Ridge
- 7 Spigner Bay

ROAD CLASSIFICATION	
Expressway	Local Connector
Secondary Hwy	Local Road
Bypass	400
Interstate Route	US Route
	State Route

SNEADS FERRY, NC
2022



APPENDIX E – Supplemental Report Documents

GBA Document

Important Information about This Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be, and, in general, if you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying it.* A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may

perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old*.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration*. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists*.



Telephone: 301/565-2733

e-mail: info@geoprofessional.org www.geoprofessional.org