

WORK RELEASE: AWP-3866 QXR JCN: 22002872  
**Long Range Radar Sustainment Project**

**QXR ARSR Facility**  
Russellville, Arkansas

**99% SUBMITTAL**

OCTOBER 17, 2022



U.S. Department of Transportation  
Federal Aviation Administration  
Western Pacific Regional Office  
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El Segundo, CA 90245



Prepared by:



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PUBLIC AVAILABILITY TO BE DETERMINED UNDER 5 USC 553

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**DOCUMENT 00 01 07****SEALS PAGE****1.01 DESIGN PROFESSIONALS OF RECORD****A. Architect:**

1. Farzin Torbati.
2. 10316.
3. Responsible for Divisions 01-49 Sections except where indicated as prepared by other design professionals of record.

**B. Civil Engineer:**

1. Ed Hickey.
2. 21169.
3. Responsible for Divisions 02, 31-32 Sections.

**C. Structural Engineer:**

1. Richard Jones.
2. 21094.
3. Responsible for Divisions 03 and 05.

**D. Fire-Protection Engineer:**

1. Frank Ataiyan.
2. 19548.
3. Responsible for Divisions 21 and 28 Sections.

**E. Mechanical Engineer:**

1. Richard Levine.
2. 19465.
3. Responsible for Divisions 22 and 23 Sections.

**F. Electrical Engineer:**

1. Stephen Butler.
2. 20015.
3. Responsible for Division 26 Sections.

**END OF DOCUMENT 00 01 07****FOR OFFICIAL USE ONLY****PUBLIC AVAILABILITY TO BE DETERMINED UNDER 5 USC 553**

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**DOCUMENT 00 01 10****TABLE OF CONTENTS****PROJECT FILES**

NOT USED

**COVER & TABLE OF CONTENTS**

PROJECT MANUAL COVER

**DIVISION 00 — PROCUREMENT AND CONTRACTING REQUIREMENTS**

00 01 07 - SEALS PAGE

00 01 10 - TABLE OF CONTENTS

00 01 15 - LIST OF DRAWINGS

00 40 00 - BID SCHEDULES

**DIVISION 01 — GENERAL REQUIREMENTS**

01 11 00 - SUMMARY OF WORK

01 31 13 - PROJECT COORDINATION

01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

01 33 00 - SUBMITTAL PROCEDURES

01 35 13.90 - SPECIAL PROJECT PROCEDURES FOR COVID-19 PANDEMIC

01 35 26 - GOVERNMENTAL SAFETY REQUIREMENTS

01 35 29 - HEALTH, SAFETY &amp; EMERGENCY RESPONSE PROCEDURES

01 45 00 - QUALITY CONTROLS

01 50 00 - TEMPORARY FACILITIES AND CONTROLS

01 60 00 - PRODUCT REQUIREMENTS

01 71 23 - FIELD ENGINEERING

01 71 33 - PROTECTION OF ADJACENT CONSTRUCTION

01 74 00 - CLEANING AND WASTE MANAGEMENT

01 77 00 - CLOSEOUT PROCEDURES

01 91 13 - GENERAL COMMISSIONING REQUIREMENTS

**DIVISION 02 — EXISTING CONDITIONS**

02 41 16 - STRUCTURE DEMOLITION

02 41 19 - SELECTIVE DEMOLITION

**DIVISION 03 — CONCRETE**

03 10 00 - CONCRETE FORMING AND ACCESSORIES

03 20 00 - CONCRETE REINFORCING

03 30 00 - CAST-IN-PLACE CONCRETE

**DIVISION 04 — MASONRY**

NOT USED

**DIVISION 05 — METALS**

05 12 00 - STRUCTURAL STEEL FRAMING

05 40 00 - COLD-FORMED METAL FRAMING

05 50 00 - METAL FABRICATIONS

05 51 19 - METAL GRATING STAIRS

05 52 13 - PIPE AND TUBE RAILINGS

05 53 13 - BAR GRATINGS

**DIVISION 06 — WOOD, PLASTICS, AND COMPOSITES**

06 10 53 - MISCELLANEOUS ROUGH CARPENTRY

06 41 16 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

06 80 00 - COMPOSITE FABRICATION

**DIVISION 07 — THERMAL AND MOISTURE PROTECTION**

07 21 00 - THERMAL INSULATION  
07 42 13.19 - INSULATED METAL WALL PANELS  
07 62 00 - SHEET METAL FLASHING AND TRIM  
07 72 00 - ROOF ACCESSORIES  
07 92 00 - JOINT SEALANTS

**DIVISION 08 — OPENINGS**

08 11 13 - HOLLOW METAL DOORS AND FRAMES  
08 31 13 - ACCESS DOORS AND FRAMES  
08 51 13 - ALUMINUM WINDOWS  
08 71 00 - DOOR HARDWARE  
08 91 19 - FIXED LOUVERS

**DIVISION 09 — FINISHES**

09 01 90.52 - MAINTENANCE REPAINTING  
09 22 16 - NON-STRUCTURAL METAL FRAMING  
09 29 00 - GYPSUM BOARD  
09 51 13 - ACOUSTICAL PANEL CEILINGS  
09 67 23 - RESINOUS FLOORING  
09 91 13 - EXTERIOR PAINTING  
09 91 23 - INTERIOR PAINTING  
09 96 00 - HIGH-PERFORMANCE COATINGS

**DIVISION 10 — SPECIALTIES**

10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES  
10 44 16 - FIRE EXTINGUISHERS  
10 71 13.19 - ROLLING EXTERIOR SHUTTERS  
10 73 13 - AWNINGS

**DIVISION 11 — EQUIPMENT**

11 30 13 - RESIDENTIAL APPLIANCES

**DIVISION 12 — FURNISHINGS**

12 36 61.16 - SOLID SURFACING COUNTERTOPS

**DIVISION 13 — SPECIAL CONSTRUCTION**

NOT USED

**DIVISION 14 — CONVEYING EQUIPMENT**

NOT USED

**DIVISION 21 — FIRE SUPPRESSION**

NOT USED

**DIVISION 22 — PLUMBING**

22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING  
22 05 23.12 - BALL VALVES FOR PLUMBING PIPING  
22 05 23.14 - CHECK VALVES FOR PLUMBING PIPING  
22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT  
22 05 33 - HEAT TRACING FOR PLUMBING PIPING  
22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT  
22 07 19 - PLUMBING PIPING INSULATION  
22 08 00 - COMMISSIONING OF PLUMBING  
22 11 16 - DOMESTIC WATER PIPING  
22 11 19 - DOMESTIC WATER PIPING SPECIALTIES  
22 13 16 - SANITARY WASTE AND VENT PIPING  
22 13 19 - SANITARY WASTE PIPING SPECIALTIES  
22 13 19.13 - SANITARY DRAINS  
22 33 00 - ELECTRIC, DOMESTIC-WATER HEATERS  
22 42 13.13 - COMMERCIAL WATER CLOSETS

22 42 16.13 - COMMERCIAL LAVATORIES

22 42 16.16 - COMMERCIAL SINKS

**DIVISION 23 — HEATING VENTILATING AND AIR CONDITIONING**

23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

23 05 33 - HEAT TRACING FOR HVAC PIPING

23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

23 08 00 - COMMISSIONING OF HVAC

23 09 23.12 - CONTROL DAMPERS

23 23 00 - REFRIGERANT PIPING

23 31 13 - METAL DUCTS

23 33 00 - AIR DUCT ACCESSORIES

23 37 13.13 - AIR DIFFUSERS

23 37 13.23 - REGISTERS AND GRILLES

23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

23 82 39.19 - WALL AND CEILING UNIT HEATERS

**DIVISION 25 — INTEGRATED AUTOMATION**

NOT USED

**DIVISION 26 — ELECTRICAL**

26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

26 05 00.10 - BASIC ELECTRICAL MATERIALS AND METHODS

26 05 05 - SELECTIVE DEMOLITION FOR ELECTRICAL

26 05 19 - LOW VOLTAGE CABLES

26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

26 05 33.10 - UNDERGROUND CONDUITS FOR ELECTRICAL SYSTEMS

26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

26 05 53 - IDENTIFICATION OF ELECTRICAL SYSTEMS

26 08 00.13 - TESTING AND INSPECTING ELECTRICAL EQUIPMENT

26 24 16 - PANELBOARDS

26 27 26 - LOW VOLTAGE WIRING DEVICES

26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

26 41 00 - FACILITY LIGHTNING PROTECTION

26 43 13 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

26 51 00 - INTERIOR LIGHTING

**DIVISION 27 — COMMUNICATIONS**

NOT USED

**DIVISION 28 — ELECTRONIC SAFETY AND SECURITY**

28 46 21.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

**DIVISION 31 — EARTHWORK**

31 05 19.13 - GEOTEXTILES FOR EARTHWORK

31 10 00 - SITE CLEARING

31 20 00 - EARTH MOVING

31 37 16.13 - RUBBLE-STONE RIPRAP

**DIVISION 32 — EXTERIOR IMPROVEMENTS**

32 05 16 - AGGREGATES FOR EXTERIOR IMPROVEMENTS

32 31 13.53 - HIGH-SECURITY CHAIN LINK FENCES AND GATES

**DIVISION 33 — UTILITIES**

NOT USED

**DIVISION 34 — TRANSPORTATION**

NOT USED

**DIVISION 35 — WATERWAY AND MARINE**

NOT USED

**DIVISION 40 — PROCESS INTERCONNECTIONS**

NOT USED

**DIVISION 41 — MATERIAL PROCESSING AND HANDLING EQUIPMENT**

NOT USED

**DIVISION 42 — PROCESS HEATING, COOLING, AND DRYING EQUIPMENT**

NOT USED

**DIVISION 43 — PROCESS GAS AND LIQUID HANDLING, PURIFICATION AND STORAGE EQUIPMENT**

NOT USED

**DIVISION 44 — POLLUTION AND WASTE CONTROL EQUIPMENT**

NOT USED

**DIVISION 45 — INDUSTRY-SPECIFIC MANUFACTURING EQUIPMENT**

NOT USED

**DIVISION 46 — WATER AND WASTEWATER EQUIPMENT**

NOT USED

**DIVISION 48 — ELECTRICAL POWER GENERATION**

NOT USED

**END OF DOCUMENT**



**DOCUMENT 00 01 15****LIST OF DRAWINGS****1.01 SUMMARY**

- A. This document lists the drawings for the project pursuant to FAA AMS Contract Clause "3.2.2.3-60, Specifications, Drawings, and Material Offers Alternate I". Contract clauses are found at the following link:

1. <https://fast.faa.gov/contractclauses.cfm>

**1.02 REFERENCES**

- A. Throughout the specification sections of the Project for this Contract with a REFERENCES paragraph, the publications listed form a part of this Project Specifications to the extent referenced. The publications are referred to within the text by the basic designation only.

**1.03 CONTRACT DRAWINGS**

- A. Contract drawings are as follows:

1. QXR ARAR BUILDING design drawings, dated OCTOBER 17, 2022

**GENERAL**

QXR - 22002872 - G001	COVER SHEET
QXR - 22002872 - G002	DRAWING INDEX

**CIVIL**

QXR - 22002872 - C001	GENERAL NOTES, ABBREVIATIONS, AND LEGEND
QXR - 22002872 - C010	EXISTING SITE & UTILITY PLAN
QXR - 22002872 - CD101	DEMOLITION PLAN
QXR - 22002872 - CD901	ELECTRICAL SITE PLAN - DEMOLITION
QXR - 22002872 - C101	SITE PLAN
QXR - 22002872 - C201	GRADING PLAN
QXR - 22002872 - C501	UTILITY PLAN
QXR - 22002872 - C701	FENCING AND GATE DETAILS
QXR - 22002872 - C801	SITE DETAILS
QXR - 22002872 - C901	ELECTRICAL SITE DETAILS

**ARCHITECTURE**

QXR - 22002872 - A001	GENERAL NOTES - ARCHITECTURE
QXR - 22002872 - A002	LEGEND, SYMBOLS, & ABBREVIATIONS
QXR - 22002872 - A004	ACCESSIBILITY
QXR - 22002872 - AS101	ARCHITECTURAL SITE PLAN
QXR - 22002872 - AD101	DEMOLITION PLAN - FIRST FLOOR
QXR - 22002872 - AD102	DEMOLITION PLAN - SECOND FLOOR
QXR - 22002872 - AD103	DEMOLITION PLAN - THIRD FLOOR

QXR - 22002872 - AD104	DEMOLITION PLAN - RADOME LEVEL
QXR - 22002872 - AD121	DEMOLITION PLAN - FIRST FLOOR REFLECTED CEILING
QXR - 22002872 - AD122	DEMOLITION PLAN - SECOND FLOOR REFLECTED CEILING
QXR - 22002872 - AD123	DEMOLITION PLAN - THIRD FLOOR REFLECTED CEILING
QXR - 22002872 - AD201	DEMOLITION OVERALL BUILDING EXTERIOR ELEVATIONS
QXR - 22002872 - A101	FIRST FLOOR PLAN
QXR - 22002872 - A111	SECOND FLOOR PLAN
QXR - 22002872 - A121	THIRD FLOOR PLAN
QXR - 22002872 - A131	RADOME PLATFORM PLAN
QXR - 22002872 - A151	FIRST FLOOR REFLECTED CEILING PLAN
QXR - 22002872 - A161	SECOND FLOOR REFLECTED CEILING PLAN
QXR - 22002872 - A171	THIRD FLOOR REFLECTED CEILING PLAN
QXR - 22002872 - A201	BUILDING ELEVATIONS
QXR - 22002872 - A202	EXTERIOR ELEVATIONS
QXR - 22002872 - A301	BUILDING SECTION
QXR - 22002872 - A302	BUILDING SECTION
QXR - 22002872 - A311	WALL SECTIONS
QXR - 22002872 - A401	ENLARGED FLOOR PLANS
QXR - 22002872 - A421	ENLARGED INTERIOR ELEVATIONS
QXR - 22002872 - A521	PLAN DETAILS
QXR - 22002872 - A601	PARTITION FRAMING DETAILS
QXR - 22002872 - A602	PARTITION BACKING PLATE DETAILS
QXR - 22002872 - A603	FRAMING DETAILS
QXR - 22002872 - A606	CEILING DETAILS
QXR - 22002872 - A608	STAIR DETAILS
QXR - 22002872 - A610	MILLWORK AND FLOOR BASE DETAILS
QXR - 22002872 - A611	RADOME ALTERNATING TREAD STAIR AND ROOF HATCH DETAILS
QXR - 22002872 - A621	DOOR SCHEDULE
QXR - 22002872 - A623	DOOR DETAILS
QXR - 22002872 - A631	PARTITION TYPES
QXR - 22002872 - A632	EXTERIOR WALL TYPES
QXR - 22002872 - A641	FINISH AND WINDOW SCHEDULES
QXR - 22002872 - A644	EXTERIOR WINDOW DETAILS

## **STRUCTURAL**

QXR - 22002872 - S001	GENERAL STRUCTURAL NOTES
QXR - 22002872 - S002	GENERAL STRUCTURAL NOTES
QXR - 22002872 - S003	GENERAL STRUCTURAL NOTES
QXR - 22002872 - S004	GENERAL STRUCTURAL NOTES
QXR - 22002872 - SD101	FIRST FLOOR DEMOLITION PLAN
QXR - 22002872 - SD102	SECOND FLOOR DEMOLITION PLAN
QXR - 22002872 - SD103	THIRD FLOOR DEMOLITION PLAN
QXR - 22002872 - SD104	ROOF / RADOME BASE DEMOLITION PLAN
QXR - 22002872 - SD301	DEMOLITION FRAME ELEVATIONS
QXR - 22002872 - SD302	DEMOLITION FRAME ELEVATIONS
QXR - 22002872 - SD303	DEMOLITION FRAME ELEVATIONS
QXR - 22002872 - SD304	DEMOLITION FRAME ELEVATIONS
QXR - 22002872 - SD305	DEMOLITION FRAME ELEVATIONS
QXR - 22002872 - S101	FIRST FLOOR PLAN
QXR - 22002872 - S102	SECOND FLOOR PLAN
QXR - 22002872 - S103	THIRD FLOOR PLAN
QXR - 22002872 - S104	ROOF / RADOME BASE PLAN
QXR - 22002872 - S301	FRAME ELEVATIONS
QXR - 22002872 - S302	FRAME ELEVATIONS
QXR - 22002872 - S303	FRAME ELEVATIONS

QXR - 22002872 - S304	FRAME ELEVATIONS
QXR - 22002872 - S305	FRAME ELEVATIONS
QXR - 22002872 - S306	FRAME ELEVATIONS
QXR - 22002872 - S601	STANDARD CONCRETE DETAILS
QXR - 22002872 - S602	STANDARD STEEL DETAILS
QXR - 22002872 - S603	SECTIONS AND DETAILS
QXR - 22002872 - S604	STAIR SECTIONS AND DETAILS
QXR - 22002872 - S605	SECTIONS AND DETAILS
QXR - 22002872 - S606	STANDARD STAIR DETAILS
QXR - 22002872 - S900	3D VIEWS
QXR - 22002872 - S901	3D VIEWS

## **MECHANICAL**

QXR - 22002872 - M001	LEGEND, SYMBOLS AND NOTES
QXR - 22002872 - MD101	DEMOLITION - FIRST FLOOR PLAN
QXR - 22002872 - MD102	DEMOLITION - SECOND FLOOR PLAN
QXR - 22002872 - MD103	DEMOLITION - THIRD FLOOR PLAN
QXR - 22002872 - M101	FIRST FLOOR PLAN
QXR - 22002872 - M102	SECOND FLOOR PLAN
QXR - 22002872 - M103	THIRD FLOOR PLAN
QXR - 22002872 - M300	SECTIONS
QXR - 22002872 - M500	EQUIPMENT SCHEDULES
QXR - 22002872 - M600	DETAILS
QXR - 22002872 - M601	DETAILS
QXR - 22002872 - M602	NDP CONTROLLER
QXR - 22002872 - M900	ISOMETRIC VIEWS

## **PLUMBING**

QXR - 22002872 - P001	LEGEND, SYMBOLS AND NOTES
QXR - 22002872 - PD101	DEMOLITION - FIRST FLOOR PLAN
QXR - 22002872 - PD102	DEMOLITION - SECOND FLOOR PLAN
QXR - 22002872 - PD103	DEMOLITION - THIRD FLOOR PLAN
QXR - 22002872 - P101	FIRST FLOOR PLAN - NEW WORK
QXR - 22002872 - P102	SECOND FLOOR PLAN - NEW WORK
QXR - 22002872 - P103	THIRD FLOOR PLAN - NEW WORK
QXR - 22002872 - P600	DETAILS
QXR - 22002872 - P601	DETAILS

## **QXR - 22002872 - P901 ISOMETRIC VIEWSELECTRICAL**

QXR - 22002872 - E001	LEGEND, SYMBOLS, NOTES AND ABBREVIATIONS
QXR - 22002872 - ED101	ELECTRICAL DEMOLITION - LIGHTING PLAN - FIRST FLOOR
QXR - 22002872 - ED102	ELECTRICAL DEMOLITION - LIGHTING PLAN - SECOND FLOOR
QXR - 22002872 - ED103	ELECTRICAL DEMOLITION - LIGHTING PLAN - THIRD FLOOR
QXR - 22002872 - ED104	ELECTRICAL DEMOLITION - LIGHTING PLAN - RADOME BASE
QXR - 22002872 - ED121	ELECTRICAL DEMOLITION - POWER PLAN - FIRST FLOOR
QXR - 22002872 - ED122	ELECTRICAL DEMOLITION - POWER PLAN - SECOND FLOOR
QXR - 22002872 - ED123	ELECTRICAL DEMOLITION - POWER PLAN - THIRD FLOOR
QXR - 22002872 - ED125	ELECTRICAL DEMOLITION - MECHANICAL POWER PLAN - FIRST FLOOR
QXR - 22002872 - ED126	ELECTRICAL DEMOLITION - MECHANICAL POWER PLAN - SECOND FLOOR
QXR - 22002872 - ED127	ELECTRICAL DEMOLITION - MECHANICAL POWER PLAN - THIRD FLOOR
QXR - 22002872 - ED801	ELECTRICAL DEMOLITION - SINGLE LINE DIAGRAM
QXR - 22002872 - E101	LIGHTING PLAN - FIRST FLOOR

QXR - 22002872 - E102	LIGHTING PLAN - SECOND FLOOR	
QXR - 22002872 - E103	LIGHTING PLAN - THIRD FLOOR	
QXR - 22002872 - E104	LIGHTING PLAN - RADOME BASE	
QXR - 22002872 - E121	POWER PLAN - FIRST FLOOR	
QXR - 22002872 - E122	POWER PLAN - SECOND FLOOR	
QXR - 22002872 - E123	POWER PLAN - THIRD FLOOR	
QXR - 22002872 - E124	POWER PLAN - RADOME BASE	
QXR - 22002872 - E125	MECHANICAL POWER PLAN - FIRST FLOOR	
QXR - 22002872 - E126	MECHANICAL POWER PLAN - SECOND FLOOR	
QXR - 22002872 - E127	MECHANICAL POWER PLAN - THIRD FLOOR	
QXR - 22002872 - E401	PHOTOMETRIC PLAN - FIRST FLOOR	
QXR - 22002872 - E402	PHOTOMETRIC PLAN - SECOND FLOOR	
QXR - 22002872 - E403	PHOTOMETRIC PLAN - THIRD FLOOR	
QXR - 22002872 - E404	PHOTOMETRIC PLAN - FOURTH FLOOR	
QXR - 22002872 - E405	ENLARGED LIGHTING PLAN - E/G BUILDING	
QXR - 22002872 - E406	ENLARGED PLAN - PUMP HOUSE	
QXR - 22002872 - E407	ENLARGED PLAN - RADOME ACCESS HATCH	
QXR - 22002872 - E408	ENLARGED LIGHTING PLAN - STAIRS	QXR - 22002872 - E501
SCHEDULES - NEW		PANELBOARD
QXR - 22002872 - E502	PANELBOARD SCHEDULES - FIRST FLOOR	
QXR - 22002872 - E503	PANELBOARD SCHEDULES - SECOND FLOOR	
QXR - 22002872 - E504	PANELBOARD SCHEDULES - THIRD FLOOR	
QXR - 22002872 - E550	LIGHTING FIXTURE SCHEDULES	
QXR - 22002872 - E801	SINGLE LINE DIAGRAM	
QXR - 22002872 - E802	SINGLE LINE DIAGRAM SCHEDULES	
QXR - 22002872 - E803	ARC FLASH SINGLE LINE DIAGRAM (FOR REFERENCE ONLY)	

## **SECURITY**

QXR - 22002872 - Y001	LEGEND, SYMBOLS, AND NOTES
QXR - 22002872 - Y101	SECURITY PLAN - FIRST FLOOR
QXR - 22002872 - Y601	SECURITY - DETAILS

## **FIRE PROTECTION**

QXR - 22002872 - F001	LEGEND, SYMBOLS AND NOTES
QXR - 22002872 - FD101	FIRE PROTECTION DEMOLITION FLOOR PLAN - FIRST FLOOR
QXR - 22002872 - FD102	FIRE PROTECTION DEMOLITION FLOOR PLAN - SECOND FLOOR
QXR - 22002872 - FD103	FIRE PROTECTION DEMOLITION FLOOR PLAN - THIRD FLOOR
QXR - 22002872 - F101	FIRE LIFE SAFETY FLOOR PLAN - FIRST FLOOR
QXR - 22002872 - F102	FIRE LIFE SAFETY FLOOR PLAN - SECOND FLOOR
QXR - 22002872 - F103	FIRE LIFE SAFETY FLOOR PLAN - THIRD FLOOR
QXR - 22002872 - F501	FIRE ALARM FLOOR PLAN - FIRST FLOOR
QXR - 22002872 - F502	FIRE ALARM FLOOR PLAN - SECOND FLOOR
QXR - 22002872 - F503	FIRE ALARM FLOOR PLAN - THIRD FLOOR
QXR - 22002872 - F541	FIRE ALARM RISER DIAGRAM
QXR - 22002872 - F551	FIRE ALARM DETAILS
QXR - 22002872 - F552	FIRE ALARM DETAILS
QXR - 22002872 - F571	FIRE ALARM CALCULATIONS

## **PART 2 - PRODUCTS**

NOT USED.

## **PART 3 - EXECUTION**

### **3.01 AVAILABILITY OF CADD DRAWING FILES**

- A. After award and upon request, the electronic "Computer-Aided Drafting and Design (CADD)" drawing files will be made available to the subcontractor for use in preparation of construction drawings and data related to the referenced contract subject to the following terms and conditions.
- B. Electronic CADD drawing files are not construction documents. Differences may exist between the CADD files and the corresponding construction documents. The subcontractor makes no representation regarding the accuracy or completeness of the electronic CADD files, nor does it make representation to the compatibility of these files with the subcontractors hardware or software. In the event a conflict arises between the signed and sealed construction documents prepared by the contractor and the furnished CADD files, the construction contract documents provided by the Contracting Officer shall govern. Use of these CADD files does not relieve the subcontractor of duty to fully comply with the contract documents, including and without limitation, the need to check, confirm and coordinate the work of all subcontractors for the project.
- C. Data contained on these electronic files shall not be used for any purpose other than as a convenience in the preparation of construction data for the referenced project. Any other use or reuse shall be at the sole risk of the subcontractor and without liability or legal exposure to the contractor. The subcontractor shall make no claim and waives to the fullest extent permitted by law, any claim or cause of action of any nature against the contractor, its agents or sub consultants that may arise out of or in connection with the use of these electronic files. The subcontractor shall, to the fullest extent permitted by law, indemnify and hold the contractor harmless against all damages, liabilities or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.
- D. If the subcontractor uses, duplicates and/or modifies these electronic CADD files for use in producing construction data related to this contract, all previous indicia of ownership (seals, logos, signatures, initials and dates) shall be removed. Subcontractor use includes producing As-built drawings required by the contract.

**END OF DOCUMENT**

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**DOCUMENT 00 40 00****BID SCHEDULES****PART 1 - GENERAL****1.01 RELATED WORK SPECIFIED ELSEWHERE**

- A. SECTION 01 20 00 PRICE AND PAYMENT PROCEDURES

**1.02 BASIS OF BIDS**

- A. This contract is solicited using bid items as the "Basis of Bids". A description of the bid items is contained in Standard Form SF 1442, "Solicitation, Offer and Award" and listed in the paragraph 1.4 BID FORM.

**1.03 SUBMITTALS**

- A. Submit the following in accordance with SECTION 01 33 00 SUBMITTAL PROCEDURES:

1. Preconstruction Submittals BID FORM

- a. The BID FORM (paragraph 1.03.B. below) lists project specific bid items to be used as the basis for submitting the Schedule of Values which must be submitted by the Subcontractor in accordance with paragraph 1.03 of SECTION 01 20 00 PRICE AND PAYMENT PROCEDURES has been provided. The subcontractor shall provide to the Contracting Officer of an electronic copy of the BID FORM; completed with a price breakdown for each item listed. Additional price breakdown data may be submitted, but not required.

- B. Bid Item Unit Price List for LRR

Bid Item	Descriptions	Price \$\$
001	Provision of all work for mobilization, I.D Badge, coordination's, lodging and per-diem for your workers and 8 hours per day work for 5 days a week. The work is to begin during the hours of 7:30am am to <b>3:30 pm</b> . But not including the work indicated or specified to be provided under any other Bid Items.	
002	Provision of all demolition work and dispose of concrete and debris off the site.	
003		

Bid Item	Descriptions	Price \$\$
004		
005	Provision of all electrical work which includes, grounding, junction box, conduits and misc. items.	
006	Provision of all work for Inspection (CAI) and de-mobilization.	
007	% overhead	
008	% profit	
009	% Bond	
010	% project close out	
011	Grand total cost	

END OF DOCUMENT



**SECTION 01 91 13****GENERAL COMMISSIONING REQUIREMENTS****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. General requirements for coordinating and scheduling commissioning activities.
2. Commissioning meetings.
3. Commissioning reports.
4. Use of commissioning process test equipment, instrumentation, and tools.
5. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
6. Commissioning tests and commissioning test demonstration.
7. Adjusting, verifying, and documenting identified systems and assemblies.

**B. Related Requirements:**

1. Section 01 11 00 "Summary" for Commissioning Authority responsibilities.
2. Section 01 33 00 "Submittal Procedures" for submittal procedure requirements for commissioning process.
3. Section 01 77 00 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.
4. Section 22 08 00 "Commissioning of Plumbing" for technical commissioning requirements for plumbing.
5. Section 23 08 00 "Commissioning of HVAC" for technical commissioning requirements for HVAC.

**1.02 ALLOWANCES****A. Labor and management costs for the performance of commissioning process.****B. The following are excluded from the commissioning allowance:**

1. Equipment and systems installation, startup, and field quality-control testing indicated in the Contract Documents.
2. Test equipment, instrumentation, and tools (including, but not limited to, proprietary test equipment, instrumentation, and tools) required to perform tests.
3. Work to correct commissioning issues.
4. Work to repeat tests when equipment and systems fail acceptance criteria.

**1.03 DEFINITIONS**

- A. Acceptance Criteria:** Threshold of acceptable work quality or performance specified for a commissioning activity, including, but not limited to, construction checklists, performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.

- B. Basis-of-Design Document: A document prepared by Architect that records concepts, calculations, decisions, and product selections used to comply with Owner's Project Requirements and to suit applicable regulatory requirements, standards, and guidelines.
- C. Commissioning Authority: An entity engaged by Owner, and identified in Section 01 11 00 "Summary," to evaluate Commissioning-Process Work.
- D. Commissioning Plan: A document, prepared by Commissioning Authority, that outlines the organization, schedule, allocation of resources, and documentation of commissioning requirements.
- E. Commissioning: A quality-focused process for verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, and tested to comply with Owner's Project Requirements. The requirements specified here are limited to the construction phase commissioning activities. The scope of the commissioning process is defined in Section 01 11 00 "Summary."
- F. Construction-Phase Commissioning-Process Completion: The stage of completion and acceptance of commissioning process when resolution of deficient conditions and issues discovered during commissioning process and retesting until acceptable results are obtained has been accomplished. Owner will establish in writing the date construction-phase commissioning-process completion is achieved. See Section 01 77 00 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.
  - 1. Commissioning process is complete when the Work specified of this Section and related Sections has been completed and accepted, including, but not limited to, the following:
    - a. Completion of tests and acceptance of test results.
    - b. Resolution of issues, as verified by retests performed and documented with acceptance of retest results.
    - c. Completion and acceptance of submittals and reports.
- G. Owner's Project Requirements: A document that details the functional requirements of a project and the expectations of how it will be used and operated, including Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This document is prepared either by the Owner or for the Owner by the Architect or Commissioning Authority.
- H. Owner's Witness: Commissioning Authority, Owner's Project Manager, or Architect-designated witness authorized to authenticate test demonstration data and to sign completed test data forms.
- I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.
- J. Test: Performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.
- K. Sampling Procedures and Tables for Inspection by Attributes: As defined in ASQ Z1.4.

#### 1.04 COMPENSATION

- A. If Architect, Commissioning Authority, other Owner's witness, or Owner's staff perform additional services or incur additional expenses due to actions of Contractor listed below, compensate Owner for such additional services and expenses.

1. Failure to provide timely notice of commissioning activities schedule changes.
2. Failure to meet acceptance criteria for test demonstrations.

- B. Contractor shall compensate Owner for such additional services and expenses at the rate of **<Insert billing rate>** per labor hour, plus **<Insert rate>** per round trip for personnel travelling more than 200 miles, plus per diem allowances for meals and lodging according to current U.S. General Services Administration (GSA) Per Diem Rates.

#### 1.05 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s):

1. Commissioning Coordinator: A person or entity employed by Contractor to manage, schedule, and coordinate commissioning process.
2. Project superintendent and other employees that Contractor may deem appropriate for a particular portion of the commissioning process.
3. Subcontractors, installers, suppliers, and specialists that Contractor may deem appropriate for a particular portion of the commissioning process.
4. Appointed team members shall have the authority to act on behalf of the entity they represent.

- B. Members Appointed by Owner:

1. Commissioning Authority, plus consultants that Commissioning Authority may deem appropriate for a particular portion of the commissioning process.
2. Owner representative(s), facility operations and maintenance personnel, plus other employees, separate contractors, and consultants that Owner may deem appropriate for a particular portion of the commissioning process.
3. Architect, plus employees and consultants that Architect may deem appropriate for a particular portion of the commissioning process.

#### 1.06 INFORMATIONAL SUBMITTALS

- A. Comply with requirements in Section 01 33 00 "Submittal Procedures" for submittal procedure general requirements for commissioning process.

- B. Commissioning Plan Information:

1. List of Contractor-appointed commissioning team members to include specific personnel and subcontractors performing the various commissioning requirements.
2. Schedule of commissioning activities, integrated with the Construction Schedule. Comply with requirements in Section 01 32 00 "Construction Progress Documentation" for the Construction Schedule general requirements for commissioning process.
3. Contractor personnel and subcontractors participating in each test.
4. List of instrumentation required for each test to include identification of parties that will provide instrumentation for each test.

- C. Commissioning schedule.

- D. Two-week look-ahead schedules.

- E. Commissioning Coordinator Letter of Authority:

1. Within 10 days after approval of Commissioning Coordinator qualifications, submit a letter of authority for Commissioning Coordinator, signed by a principal of Contractor's firm. Letter shall authorize Commissioning Coordinator to do the following:
  - a. Make inspections required for commissioning process.
  - b. Coordinate, schedule, and manage commissioning process of Contractor, subcontractors, and suppliers.
  - c. Obtain documentation required for commissioning process from Contractor, subcontractors, and suppliers.
  - d. Report issues, delayed resolution of issues, schedule conflicts, and lack of cooperation or expertise on the part of members of the commissioning team.
- F. Commissioning Coordinator Qualification Data: For entity coordinating Contractor's commissioning activities to demonstrate their capabilities and experience.
  1. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- G. List test instrumentation, equipment, and monitoring devices. Include the following information:
  1. Make, model, serial number, and application for each instrument, equipment, and monitoring device.
  2. Brief description of intended use.
  3. Calibration record showing the following:
    - a. Calibration agency, including name and contact information.
    - b. Last date of calibration.
    - c. Range of values for which calibration is valid.
    - d. Certification of accuracy.
    - e. Certification for calibration equipment traceable to NIST.
    - f. Due date of the next calibration.
- H. Test Reports:
  1. Pre-Startup Report: Prior to startup of equipment or a system, submit signed, completed construction checklists.
  2. Test Data Reports: At the end of each day in which tests are conducted, submit test data for tests performed.
  3. Commissioning Issue Reports: Daily, at the end of each day in which tests are conducted, submit commissioning issue reports for tests for which acceptable results were not achieved.
  4. Weekly Progress Report: Weekly, at the end of each week in which tests are conducted, submit a progress report.
  5. Data Trend Logs: Submit data trend logs at the end of the trend log period.
  6. System Alarm Logs: Daily, at the start of days following a day in which tests were performed, submit printout of log of alarms that occurred since the last log was printed.
- I. Construction Checklists:
  1. Material checks.
  2. Installation checks.
  3. Startup procedures, where required.

## 1.07 CLOSEOUT SUBMITTALS

### A. Commissioning Report:

1. At Construction-Phase Commissioning Completion, include the following:
  - a. Pre-startup reports.
  - b. Approved test procedures.
  - c. Test data forms, completed and signed.
  - d. Progress reports.
  - e. Commissioning issue report log.
  - f. Commissioning issue reports showing resolution of issues.
  - g. Correspondence or other documents related to resolution of issues.
  - h. Other reports required by commissioning process.
  - i. List unresolved issues and reasons they remain unresolved and should be exempted from the requirements for Construction-Phase Commissioning Completion.
  - j. Report shall include commissioning work of Contractor.

### B. Request for Certificate of Construction-Phase Commissioning Process Completion.

### C. Operation and Maintenance Data: For proprietary test equipment, instrumentation, and tools to include in operation and maintenance manuals.

## 1.08 QUALITY ASSURANCE

### A. Commissioning Coordinator Qualifications:

1. Documented experience commissioning systems of similar complexity to those contained in these documents on at least three projects of similar scope and complexity.
2. Certification of commissioning-process expertise. The following certifications are acceptable. Owner reserves the right to accept or reject certifications as evidence of qualification.
  - a. Certified Commissioning Authority, by AABC Commissioning Group (ACG).
  - b. Commissioning-Process Management Professional, by American Society of Heating, Refrigerating and Air-Conditioning Engineers.
  - c. Certified Commissioning Professional, by Building Commissioning Association.
  - d. Accredited Commissioning-Process Authority Professional, by University of Wisconsin.
  - e. Accredited Commissioning-Process Manager, by University of Wisconsin.
  - f. Accredited Green Commissioning-Process Provider, by University of Wisconsin.

### B. Calibration Agency Qualifications: Certified by The American Association for Laboratory Accreditation that the calibration agency complies with minimum requirements of ISO/IEC 17025.

## PART 2 - PRODUCTS

### 2.01 TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

- A. Test equipment and instrumentation required to perform the commissioning process shall remain the property of Contractor unless otherwise indicated.
- B. Test equipment and instrumentation required to perform commissioning process shall comply with the following criteria:

1. Be manufactured for the purpose of testing and measuring tests for which they are being used and have an accuracy to test and measure system performance within the tolerances required to determine acceptable performance.
2. Calibrated and certified.
  - a. Calibration performed and documented by a qualified calibration agency according to national standards applicable to the tools and instrumentation being calibrated. Calibration shall be current according to national standards or within test equipment and instrumentation manufacturer's recommended intervals, whichever is more frequent, but not less than within six months of initial use on Project. Calibration tags shall be permanently affixed.
  - b. Repair and recalibrate test equipment and instrumentation if dismantled, dropped, or damaged since last calibrated.
3. Maintain test equipment and instrumentation.
4. Use test equipment and instrumentation only for testing or monitoring Work for which they are designed.

## 2.02 PROPRIETARY TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

- A. Proprietary test equipment, instrumentation, and tools are those manufactured or prescribed by tested equipment manufacturer and required for work on its equipment as a condition of equipment warranty, or as otherwise required to service, repair, adjust, calibrate, or perform work on its equipment.
  1. Identify proprietary test equipment, instrumentation, and tools required in the test equipment identification list submittal.
  2. Proprietary test equipment, instrumentation, and tools shall become the property of Owner at Substantial Completion.

## 2.03 REPORT FORMAT AND ORGANIZATION

- A. General Format and Organization:
  1. Bind report in three-ring binders.
  2. Label the front cover and spine of each binder with the report title, volume number, project name, Contractor's name, and date of report.
  3. Record report on compact disk.
  4. Electronic Data: Portable document format (PDF); a single file with outline-organized bookmarks for major and minor tabs and tab contents itemized for specific reports.
- B. Commissioning Report:
  1. Include a table of contents and an index to each test.
  2. Include major tabs for each Specification Section.
  3. Include minor tabs for each test.
  4. Within each minor tab, include the following:
    - a. Test specification.
    - b. Pre-startup reports.
    - c. Approved test procedures.
    - d. Test data forms, completed and signed.

- e. Commissioning issue reports, showing resolution of issues, and documentation related to resolution of issues pertaining to a single test. Group data forms, commissioning issue reports showing resolution of issues, and documentation related to resolution of issues for each test repetition together within the minor tab, in reverse chronological order (most recent on top).

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Review preliminary construction checklists and preliminary test procedures and data forms.

### **3.02 CONSTRUCTION CHECKLISTS**

- A. Construction checklists cannot modify or conflict with the Contract Documents.
- B. Create construction checklists based on actual systems and equipment to be included in Project.
- C. Material Checks: Compare specified characteristics and approved submittals with materials as received. Include factory tests and other evaluations, adjustments, and tests performed prior to shipment if applicable.
  - 1. Service connection requirements, including configuration, size, location, and other pertinent characteristics.
  - 2. Included optional features.
  - 3. Delivery Receipt Check: Inspect and record physical condition of materials and equipment on delivery to Project site, including agreement with approved submittals, cleanliness, and lack of damage.
  - 4. Installation Checks:
    - a. Location according to Drawings and approved Shop Drawings.
    - b. Configuration.
    - c. Compliance with manufacturers' written installation instructions.
    - d. Attachment to structure.
    - e. Access clearance to allow for maintenance, service, repair, removal, and replacement without the need to disassemble or remove other equipment or building elements. Access coordinated with other building elements and equipment, including, but not limited to, ceiling and wall access panels, in a manner consistent with OSHA fall-protection regulations and safe work practices.
    - f. Utility connections are of the correct characteristics, as applicable.
    - g. Correct labeling and identification.
    - h. Startup Checks: Verify readiness of equipment to be energized. Include manufacturer's standard startup procedures and forms.
- D. Startup: Perform and document initial operation of equipment to prove that it is installed properly and operates as intended according to manufacturer's standard startup procedures, at minimum.
- E. Performance Tests:
  - 1. Static Tests: As specified elsewhere, including, but not limited to, duct and pipe leakage tests, insulation-resistance tests, and water-penetration tests.

2. Component Performance Tests: Tests evaluate the performance of an input or output of components under a full range of operating conditions.
3. Equipment and Assembly Performance Tests: Test and evaluate performance of equipment and assemblies under a full range of operating conditions and loads.
4. System Performance Tests: Test and evaluate performance of systems under a full range of operating conditions and loads.
5. Intersystem Performance Tests: Test and evaluate the interface of different systems under a full range of operating conditions and loads.

F. Deferred Construction Checklists: Obtain Owner approval of proposed deferral of construction checklists, including proposed schedule of completion of each deferred construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, deferred construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:

1. Identify deferred construction checklists by number and title.
2. Provide a target schedule for completion of deferred construction checklists.
3. Written approval of proposed deferred construction checklists, including approved schedule of completion of each deferred construction checklist.

G. Delayed Construction Checklists: Obtain Owner approval of proposed delayed construction checklists, including proposed schedule of completion of each delayed construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, delayed construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:

1. Identify delayed construction checklist by construction checklist number and title.
2. Provide a target schedule for completion of delayed construction checklists.
3. Written approval of proposed delayed construction checklists, including approved schedule of completion of each delayed construction checklist.

### 3.03 GENERAL EXECUTION REQUIREMENTS

- A. Schedule and coordinate commissioning process with the Construction Schedule.
- B. Perform activities identified in construction checklists, including tests, and document results of actions as construction proceeds.
- C. Perform test demonstrations for Owner's witness. Unless otherwise indicated, demonstrate tests for 100 percent of work to which the test applies. In some instances, demonstration of a random sample of other than 100 percent of the results of a test is specified.
  1. Where sampling is specified, the sampling plan and procedure for the test demonstration shall be determined using ASQ Z1.4.
    - a. General Inspection: [Level I] [Level II] [Level III] .
    - b. Special Inspection: [Level S-1] [Level S-2] [Level S-3] [Level S-4] .
    - c. Acceptance Quality Limit (AQL) of 1.5.
  2. The "lot size" in ASQ Z1.4 is the sum of the number of items to which the test demonstration applies, as described in the scope subparagraph of each test.



3. On determination of the sample size, the samples shall be selected randomly by Owner's witness at the time of the test demonstration.
  4. Include in the Commissioning Plan a detailed list of the test demonstrations with lot and sample quantities for each test.
- D. Report test data and commissioning issue resolutions.
- E. Schedule personnel to participate in and perform Commissioning-Process Work.
- F. Installing contractors' commissioning responsibilities include, but are not limited to, the following:
1. Operating the equipment and systems they install during tests.
  2. In addition, installing contractors may be required to assist in tests of equipment and systems with which their work interfaces.

### 3.04 COMMISSIONING COORDINATOR RESPONSIBILITIES

- A. Management and Coordination: Manage, schedule, and coordinate commissioning process, including, but not limited to, the following:
1. Coordinate with subcontractors on their commissioning responsibilities and activities.
  2. Obtain, assemble, and submit commissioning documentation.
  3. Conduct periodic on-site commissioning meetings. Comply with requirements in Section 01 31 13 "Project Coordination."
  4. Develop and maintain the commissioning schedule. Integrate commissioning schedule into the Construction Schedule. Update Construction Schedule at specified intervals.
  5. Review and comment on preliminary test procedures and data forms.
  6. Report inconsistencies and issues in system operations.
  7. Verify that tests have been completed and results comply with acceptance criteria, and that equipment and systems are ready before scheduling test demonstrations.
  8. Direct and coordinate test demonstrations.
  9. Coordinate witnessing of test demonstrations by Owner's witness.
  10. Coordinate and manage training. Be present during training sessions to direct video recording, present training, and direct the training presentations of others.
  11. Prepare and submit specified commissioning reports.
  12. Track commissioning issues until resolution and retesting is successfully completed.
  13. Retain original records of Commissioning-Process Work, organized as required for the commissioning report. Provide Owner's representative access to these records on request.
  14. Assemble and submit commissioning report.

### 3.05 COMMISSIONING TESTING

- A. Quality Control: Construction checklists, including tests, are quality-control tools designed to improve the functional quality of Project. Test demonstrations evaluate the effectiveness of Contractor's quality-control process.
- B. Owner's witness will be present to witness commissioning work requiring the signature of an owner's witness, including, but not limited to, test demonstrations. Owner's project manager will coordinate attendance by Owner's witness with Contractor's published Commissioning Schedule. Owner's witness will provide no labor or materials in the commissioning work. The only function of Owner's witness will be to observe and comment on the progress and results of commissioning process.
- C. Construction Checklists:

1. Complete construction checklists as Work is completed.
  2. Distribute construction checklists to installing contractors before they start work.
  3. Installers:
    - a. Verify installation using approved construction checklists as Work proceeds.
    - b. Complete and sign construction checklists daily for work performed during the preceding day.
  4. Provide Commissioning Authority access to construction checklists.
- D. Installation Compliance Issues: Record as an installation compliance issue Work found to be incomplete, inaccessible, at variance with the Contract Documents, nonfunctional, or that does not comply with construction checklists. Record installation compliance issues on the construction checklist at the time they are identified. Record corrective action and how future Work should be modified before signing off the construction checklist.
- E. Pre-Startup Audit: Prior to executing startup procedures, review completed installation checks to determine readiness for startup and operation. Report conditions, which, if left uncorrected, adversely impact the ability of systems or equipment to operate satisfactorily or to comply with acceptance criteria. Prepare pre-startup report for each system.
- F. Test Procedures and Test Data Forms:
1. Test procedures shall define the step-by-step procedures to be used to execute tests and test demonstrations.
  2. Test procedures shall be specific to the make, model, and application of the equipment and systems being tested.
  3. Completed test data forms are the official records of the test results.
  4. Commissioning Authority will provide to Contractor preliminary test procedures and test data forms for performance tests and commissioning tests after approval of Product Data, Shop Drawings, and preliminary operation and maintenance manual.
  5. Review preliminary test procedures and test data forms, and provide comments within 14 days of receipt from Commissioning Authority. Review shall address the following:
    - a. Equipment protection and warranty issues, including, but not limited to, manufacturers' installation and startup recommendations, and operation and maintenance instructions.
    - b. Applicability of the procedure to the specific software, equipment, and systems approved for installation.
  6. After Contractor has reviewed and commented on the preliminary test procedures and test data forms, Commissioning Authority will revise and reissue the approved revised test procedures and test data forms marked "Approved for Testing."
  7. Use only approved test procedures and test data forms marked "Approved for Testing" to perform and document tests and test demonstrations.
- G. Performance of Tests:
1. The sampling rate for tests is 100 percent. The sampling rate for test demonstrations is 100 percent unless otherwise indicated.
  2. Perform and complete each step of the approved test procedures in the order listed.
  3. Record data observed during performance of tests on approved data forms at the time of test performance and when the results are observed.

4. Record test results that are not within the range of acceptable results on commissioning issue report forms in addition to recording the results on approved test procedures and data forms according to the "Commissioning Compliance Issues" Paragraph in this Article.
5. On completion of a test, sign the completed test procedure and data form. Tests for which test procedures and data forms are incomplete, not signed, or which indicate performance that does not comply with acceptance criteria will be rejected. Tests for which test procedures and data forms are rejected shall be repeated and results resubmitted.

H. Performance of Test Demonstration:

1. Perform test demonstrations on a sample of tests after test data submittals are approved. The sampling rate for test demonstrations shall be 100 percent unless otherwise indicated in the individual test specification.
2. Notify Owner's witness at least three days in advance of each test demonstration.
3. Perform and complete each step of the approved test procedures in the order listed.
4. Record data observed during performance of test demonstrations on approved data forms at the time of demonstration and when the results are observed.
5. Provide full access to Owner's witness to directly observe the performance of all aspects of system response during the test demonstration. On completion of a test demonstration, sign the completed data form and obtain signature of Owner's witness at the time of the test to authenticate the reported results.
6. Test demonstration data forms not signed by Contractor and Owner's witness at the time of the completion of the procedure will be rejected. Test demonstrations for which data forms are rejected shall be repeated and results shall be resubmitted.
  - a. Exception for Failure of Owner's Witness to Attend: Failure of Owner's witness to be present for agreed-on schedule of test demonstration shall not delay Contractor. If Owner's witness fails to attend a scheduled test, Contractor shall proceed with the scheduled test. On completion, Contractor shall sign the data form for Contractor and for Owner's witness, and shall note the absence of Owner's witness at the scheduled time and place.
7. False load test requirements are specified in related sections.
  - a. Where false load testing is specified, provide temporary equipment, power, controls, wiring, piping, valves, and other necessary equipment and connections required to apply the specified load to the system. False load system shall be capable of steady-state operation and modulation at the level of load specified. Equipment and systems permanently installed in this work shall not be used to create the false load without Architect's written approval.

I. Deferred Tests:

1. Deferred Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed deferred tests or other tests approved for deferral until specified seasonal or other conditions are available. When approved, deferred tests may be completed after the date of Construction-Phase Commissioning Completion. Identify proposed deferred tests in the request for Certificate of Construction-Phase Commissioning Process Completion as follows:
  - a. Identify deferred tests by number and title.
  - b. Provide a target schedule for completion of deferred tests.

2. Schedule and coordinate deferred tests. Schedule deferred tests when specified conditions are available. Notify Architect and Commissioning Authority at least three working days (minimum) in advance of tests.
3. Where deferred tests are specified, coordinate participation of necessary personnel and of Architect, Commissioning Authority, and Owner's witness. Schedule deferred tests to minimize occupant and facility impact. Obtain Architect's approval of the proposed schedule.

J. Delayed Tests:

1. Delayed Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed delayed tests. Obtain Owner approval of proposed delayed tests, including proposed schedule of completion of each delayed test, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. Include the following in the request for Certificate of Construction-Phase Commissioning Process Completion:
  - a. Identify delayed tests by test number and title.
  - b. Written approval of proposed delayed tests, including approved schedule of completion of delayed tests.
2. Schedule and coordinate delayed tests. Schedule delayed tests when conditions that caused the delay have been rectified. Notify Architect and Commissioning Authority at least three working days (minimum) in advance of tests.
3. Where delayed tests are approved, coordinate participation of necessary personnel and of Architect, Commissioning Authority, and Owner's witness. Schedule delayed tests to minimize occupant and facility impact. Obtain Architect's approval of the proposed schedule.

K. Commissioning Compliance Issues:

1. Test results that are not within the range of acceptable results are commissioning compliance issues.
2. Track and report commissioning compliance issues until resolution and retesting are successfully completed.
3. If a test demonstration fails, determine the cause of failure. Direct timely resolution of issue and then repeat the demonstration. If a test demonstration must be repeated due to failure caused by Contractor work or materials, reimburse Owner for billed costs for the participation in the repeated demonstration.
4. Test Results: If a test demonstration fails to meet the acceptance criteria, perform the following:
  - a. Complete a commissioning compliance issue report form promptly on discovery of test results that do not comply with acceptance criteria.
  - b. Submit commissioning compliance issue report form within 24 hours of the test.
  - c. Determine the cause of the failure.
  - d. Establish responsibility for corrective action if the failure is due to conditions found to be Contractor's responsibility.
5. Commissioning Compliance Issue Report: Provide a commissioning compliance issue report for each issue. Do not report multiple issues on the same commissioning compliance issue report.
  - a. Exception: If an entire class of devices is determined to exhibit the identical issue, they may be reported on a single commissioning compliance issue report. (For example, if all return-air damper actuators that are specified to fail to the open position are found to fail to the closed position, they may be reported on a single commissioning issue re-

port. If a single commissioning issue report is used for multiple commissioning compliance issues, each device shall be identified in the report, and the total number of devices at issue shall be identified.

- b. Complete and submit Part 1 of the commissioning compliance issue report immediately when the condition is observed.
  - c. Record the commissioning compliance issue report number and describe the deficient condition on the data form.
  - d. Resolve commissioning compliance issues promptly. Complete and submit Part 2 of the commissioning compliance issue report when issues are resolved.
6. Diagnose and correct failed test demonstrations as follows:
- a. Perform diagnostic tests and activities required to determine the fundamental cause of issues observed.
  - b. Record each step of the diagnostic procedure prior to performing the procedure. Update written procedure as changes become necessary.
  - c. Record the results of each step of the diagnostic procedure.
  - d. Record the conclusion of the diagnostic procedure on the fundamental cause of the issue.
  - e. Determine and record corrective measures.
  - f. Include diagnosis of fundamental cause of issues in commissioning compliance issue report.
7. Retest:
- a. Schedule and repeat the complete test procedure for each test demonstration for which acceptable results are not achieved. Obtain signature of Owner's witness on retest data forms. Repeat test demonstration until acceptable results are achieved. Except for issues that are determined to result from design errors or omissions, or other conditions beyond Contractor's responsibility, compensate Owner for direct costs incurred as the result of repeated test demonstrations to achieve acceptable results.
  - b. For each repeated test demonstration, submit a new test data form, marked "Retest."
8. Do not correct commissioning compliance issues during test demonstrations.
- a. Exceptions will be allowed if the cause of the issue is obvious and resolution can be completed in less than five minutes. If corrections are made under this exception, note the deficient conditions on the test data form and issue a commissioning compliance issue report. A new test data form, marked "Retest," shall be initiated after the resolution has been completed.

### 3.06 COMMISSIONING MEETINGS

- A. Commissioning Authority will schedule and conduct commissioning meetings. Comply with requirements in Section 01 31 13 "Project Coordination."

### 3.07 SEQUENCING

- A. Sequencing of Commissioning Verification Activities: For a particular material, item of equipment, assembly, or system, perform the following in the order listed unless otherwise indicated:

- 1. Construction Checklists:

- a. Material checks.
- b. Installation checks.
- c. Startup, as appropriate. Some startup may depend on component performance. Such startup may follow component performance tests on which the startup depends.
- d. Performance Tests:
  - 1) Static tests, as appropriate.
  - 2) Component performance tests. Some component performance tests may depend on completion of startup. Such component performance tests may follow startup.
  - 3) Equipment and assembly performance tests.
  - 4) System performance tests.
  - 5) Intersystem performance tests.

2. Commissioning tests.

- B. Before performing commissioning tests, verify that materials, equipment, assemblies, and systems are delivered, installed, started, and adjusted to perform according to construction checklists.
- C. Verify readiness of materials, equipment, assemblies, and systems by performing tests prior to performing test demonstrations. Notify Architect if acceptable results cannot be achieved due to conditions beyond Contractor's control or responsibility.
- D. Commence tests as soon as installation checks for materials, equipment, assemblies, or systems are satisfactorily completed. Tests of a particular system may proceed prior to completion of other systems, provided the incomplete work does not interfere with successful execution of test.

### 3.08 SCHEDULING

- A. Commence commissioning process as early in the construction period as possible.
- B. Commissioning Schedule: Integrate commissioning activities into Construction Schedule. See Section 01 32 00 "Construction Progress Documentation."
  - 1. Include detailed commissioning activities in monthly updated Construction Schedule and short-interval schedule submittals.
  - 2. Schedule the start date and duration for the following commissioning activities:
    - a. Submittals.
    - b. Preliminary operation and maintenance manual submittals.
    - c. Installation checks.
    - d. Startup, where required.
    - e. Performance tests.
    - f. Performance test demonstrations.
    - g. Commissioning tests.
    - h. Commissioning test demonstrations.
  - 3. Schedule shall include a line item for each installation check, startup, and test activity specific to the equipment or systems involved.
  - 4. Determine milestones and prerequisites for commissioning process. Show commissioning milestones, prerequisites, and dependencies in monthly updated critical-path-method construction schedule and short-interval schedule submittals.
- C. Two-Week Look-Ahead Commissioning Schedule:

1. Two weeks prior to the beginning of tests, submit a detailed two-week look-ahead schedule. Thereafter, submit updated two-week look-ahead schedules weekly for the duration of commissioning process.
2. Two-week look-ahead schedules shall identify the date, time, beginning location, Contractor personnel required, and anticipated duration for each startup or test activity.
3. Use two-week look-ahead schedules to notify and coordinate participation of Owner's witnesses.

D. Owner's Witness Coordination:

1. Coordinate Owner's witness participation via Architect.
2. Notify Architect of commissioning schedule changes at least two work days in advance for activities requiring the participation of Owner's witness.

### 3.09 COMMISSIONING REPORTS

A. Test Reports:

1. Pre-startup reports include observations of the conditions of installation, organized into the following sections:
  - a. Equipment Model Verification: Compare contract requirements, approved submittals, and provided equipment. Note inconsistencies.
  - b. Preinstallation Physical Condition Checks: Observe physical condition of equipment prior to installation. Note conditions including, but not limited to, physical damage, corrosion, water damage, or other contamination or dirt.
  - c. Preinstallation Component Verification Checks: Verify components supplied with the equipment, preinstalled or field installed, are correctly installed and functional. Verify external components required for proper operation of equipment correctly installed and functional. Note missing, improperly configured, improperly installed, or nonfunctional components.
  - d. Summary of Installation Compliance Issues and Corrective Actions: Identify installation compliance issues and the corrective actions for each. Verify that issues noted have been corrected.
  - e. Evaluation of System Readiness for Startup: For each item of equipment for each system for which startup is anticipated, document in summary form acceptable to Owner completion of equipment model verification, preinstallation physical condition checks, preinstallation component verification checks, and completion of corrective actions for installation compliance issues.
2. Test data reports include the following:
  - a. "As-tested" system configuration. Complete record of conditions under which the test was performed, including, but not limited to, the status of equipment, systems, and assemblies; temporary adjustments and settings; and ambient conditions.
  - b. Data and observations, including, but not limited to, data trend logs, recorded during the tests.
  - c. Signatures of individuals performing and witnessing tests.
  - d. Data trend logs accumulated overnight from the previous day of testing.
3. Commissioning Compliance Issue Reports: Report as commissioning compliance issues results of tests and test demonstrations that do not comply with acceptance criteria. Report only one issue per commissioning compliance issue report. Use sequentially numbered facsimiles of commissioning compliance issue report form included in this Section, or other form ap-



proved by Owner. Distribute commissioning compliance issue reports to parties responsible for taking corrective action. Identify the following:

- a. Commissioning compliance issue report number. Assign unique, sequential numbers to individual commissioning compliance issue reports when they are created, to be used for tracking.
  - b. Action distribution list.
  - c. Report date.
  - d. Test number and description.
  - e. Equipment identification and location.
  - f. Briefly describe observations about the performance associated with failure to achieve acceptable results. Identify the cause of failure if apparent.
  - g. Diagnostic procedure or plan to determine the cause (include in initial submittal)
  - h. Diagnosis of fundamental cause of issues as specified below (include in resubmittal).
  - i. Fundamental cause of unacceptable performance as determined by diagnostic tests and activities.
  - j. When issues have been resolved, update and resubmit the commissioning issue report forms by completing Part 2. Identify resolution taken and the dates and initials of the persons making the entries.
  - k. Schedule for retesting.
4. Weekly progress reports include information for tests conducted since the preceding report and the following:
- a. Completed data forms.
  - b. Equipment or system tested, including test number, system or equipment tag number and location, and notation about the apparent acceptability of results.
  - c. Activities scheduled but not conducted per schedule.
  - d. Commissioning compliance issue report log.
  - e. Schedule changes for remaining Commissioning-Process Work, if any.
5. Data trend logs shall be initiated and running prior to the time scheduled for the test demonstration.
- a. Trend log data format shall be multiple data series graphs. Where multiple data series are trend logged concurrently, present the data on a common horizontal time axis. Individual data series may be presented on a segmented vertical axis to avoid interference of one data series with another, and to accommodate different axis scale values. Graphs shall be sufficiently clear to interpret data within the accuracy required by the acceptance criteria.
  - b. Attach to the data form printed trend log data collected during the test or test demonstration.
  - c. Record, print out, and attach to the data form operator activity during the time the trend log is running. During the time the trend log is running, operator intervention not directed by the test procedure invalidates the test results.
6. System Alarm Logs: Record and print out a log of alarms that occurred since the last log was printed. Evaluate alarms to determine if the previous day's work resulted in any conditions that are not considered "normal operation."
- a. Conditions that are not considered "normal operation" shall be reported on a commissioning issue report attached to the alarm log. Resolve as necessary. The intent of this requirement is to discover control system points or sequences left in manual or disabled conditions, equipment left disconnected, set points left with abnormal values, or



similar conditions that may have resulted from failure to fully restore systems to normal, automatic control after test completion.

### 3.10 CERTIFICATE OF CONSTRUCTION-PHASE COMMISSIONING PROCESS COMPLETION

- A. When Contractor considers that construction-phase commissioning process, or a portion thereof which Owner agrees to accept separately, is complete, Contractor shall prepare and submit to Owner and Commissioning Authority through Architect a comprehensive list of items to be completed or corrected. Failure to include an item on such list does not alter Contractor's responsibility to compete commissioning process.
- B. On receipt of Contractor's list, Commissioning Authority will make an inspection to determine whether the construction-phase commissioning process or designated portion thereof is complete. If Commissioning Authority's inspection discloses items, whether included on Contractor's list, which is not sufficiently complete as defined in "Construction-Phase Commissioning Process Completion" Paragraph in the "Definitions" Article, Contractor shall, before issuance of the Certificate of Construction-Phase Commissioning Process Completion, complete or correct such items on notification by Commissioning Authority. In such case, Contractor shall then submit a request for another inspection by Commissioning Authority to determine construction-phase commissioning process completion.
- C. Contractor shall promptly correct deficient conditions and issues discovered during commissioning process. Costs of correcting such deficient conditions and issues, including additional testing and inspections, the cost of uncovering and replacement, and compensation for Architect's and Commissioning Authority's services and expenses made necessary thereby, shall be at Contractor's expense.
- D. When construction-phase commissioning process or designated portion is complete, Commissioning Authority will prepare a Certificate of Construction-Phase Commissioning Process Completion that shall establish the date of completion of construction-phase commissioning process. Certificate of Construction-Phase Commissioning Process Completion shall be submitted prior to requesting inspection for determining date of Substantial Completion.

### END OF SECTION

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**SECTION 02 41 16**  
**STRUCTURE DEMOLITION**

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Demolition and removal of buildings and site improvements.
2. Removing below-grade construction.
3. Disconnecting, capping or sealing, and removing site utilities.
4. Salvaging items for reuse by Owner.

**B. Related Requirements:**

1. Section 02 41 19 "Selective Demolition" for partial demolition of buildings, structures, and site improvements.
2. Section 31 10 00 "Site Clearing" for site clearing and removal of above- and below-grade site improvements not part of building demolition.

**1.02 DEFINITIONS**

- A. Remove:** Detach items from existing construction and dispose of them off-site unless indicated to be salvaged.
- B. Remove and Salvage:** Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

**1.03 MATERIALS OWNERSHIP**

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.**
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.**
1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

**1.04 INFORMATIONAL SUBMITTALS**

- A. Qualification Data:** For refrigerant recovery technician.

- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control, and for noise control. Indicate proposed locations and construction of barriers.
  - 1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain including means of egress from those buildings.
- C. Schedule of Building Demolition Activities: Indicate the following:
  - 1. Detailed sequence of demolition work, with starting and ending dates for each activity.
  - 2. Temporary interruption of utility services.
  - 3. Shutoff and capping or re-routing of utility services.
- D. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

#### 1.05 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

#### 1.06 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

#### 1.07 FIELD CONDITIONS

- A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
- B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
  - 1. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
  - 2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
    - a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.
- C. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - 1. Hazardous materials will be removed by Owner before start of the Work.
  - 2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

- E. Hazardous Materials: Present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
  - 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
  - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
- F. On-site storage or sale of removed items or materials is not permitted.

#### 1.08 COORDINATION

- A. Arrange demolition schedule so as not to interfere with Owner's on-site operations.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

#### 2.02 SOIL MATERIALS

- A. Satisfactory Soils: Comply with requirements in Section 31 20 00 "Earth Moving."

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- E. Inventory and record the condition of items to be removed and salvaged.

### 3.02 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.
- B. Salvaged Items: Comply with the following:
  - 1. Clean salvaged items of dirt and demolition debris.
  - 2. Pack or crate items after cleaning. Identify contents of containers.
  - 3. Store items in a secure area until delivery to Owner.
  - 4. Transport items to storage area designated by Owner.
  - 5. Protect items from damage during transport and storage.

### 3.03 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Utilities to Be Disconnected: Locate, identify, disconnect, and seal or cap off utilities serving buildings and structures to be demolished.
  - 1. Owner will arrange to shut off utilities when requested by Contractor.
  - 2. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
  - 3. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
  - 4. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

### 3.04 PROTECTION

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
- B. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
  - 1. Strengthen or add new supports when required during progress of demolition.
- C. Existing Utilities to Remain: Maintain utility services to remain and protect from damage during demolition operations.
  - 1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
  - 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.
    - a. Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
- D. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Section 01 50 00 "Temporary Facilities and Controls."

1. Protect adjacent buildings and facilities from damage due to demolition activities.
  2. Protect existing site improvements, appurtenances, and landscaping to remain.
  3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
  4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
  6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
  7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
- E. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

### 3.05 DEMOLITION, GENERAL

- A. General: Demolish indicated buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
  2. Maintain fire watch during and for at least 12 hours after flame-cutting operations.
  3. Maintain adequate ventilation when using cutting torches.
  4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.
  2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- C. Explosives: Use of explosives is not permitted.

### 3.06 DEMOLITION BY MECHANICAL MEANS

- A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
- B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.

- C. Salvage: Items to be removed and salvaged are indicated on Drawings.
- D. Below-Grade Construction: Demolish foundation walls and other below-grade construction.
  - 1. Remove below-grade construction, including basements, foundation walls, and footings, completely.
- E. Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.

### 3.07 SITE RESTORATION

- A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.
- B. Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials according to backfill requirements in Section 31 20 00 "Earth Moving."
- C. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

### 3.08 REPAIRS

- A. Promptly repair damage to adjacent buildings caused by demolition operations.

### 3.09 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and recycle or dispose of them according to Section 01 74 00 "Cleaning and Waste Management."
  - 1. Do not allow demolished materials to accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Do not burn demolished materials.

### 3.10 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.
  - 1. Clean roadways of debris caused by debris transport.

**END OF SECTION 02 41 16**



**SECTION 02 41 19**  
**SELECTIVE DEMOLITION**

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

**B. Related Requirements:**

1. Section 31 10 00 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.

**1.02 DEFINITIONS**

- A. Remove:** Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage:** Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall:** Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain:** Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle:** To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

**1.03 MATERIALS OWNERSHIP**

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.**
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.**
1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection ,and for dust control. Indicate proposed locations and construction of barriers.
- D. Schedule of Selective Demolition Activities: Indicate the following:
  - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
  - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
  - 3. Coordination for shutoff, capping, and continuation of utility services.
  - 4. Use of elevator and stairs.
  - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- F. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

#### 1.05 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

#### 1.06 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

#### 1.07 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - 1. Hazardous materials will be removed by Owner before start of the Work.

2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
  - E. Hazardous Materials: Present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
    1. Hazardous material remediation is specified elsewhere in the Contract Documents.
    2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
    3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
  - F. Storage or sale of removed items or materials on-site is not permitted.
  - G. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
    1. Maintain fire-protection facilities in service during selective demolition operations.
- 1.08 COORDINATION
- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

## **PART 2 - PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- E. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video.
  1. Inventory and record the condition of items to be removed and salvaged.
  2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

### 3.02 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

### 3.03 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
  1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
  2. Arrange to shut off utilities with utility companies.
  3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
  4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
    - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

### 3.04 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
  - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
  - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
  - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 50 00 "Temporary Facilities and Controls."
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
  - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

### 3.05 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
  - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
  - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
  - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
  - 5. Maintain fire watch during and for at least 8 hours after flame-cutting operations.
  - 6. Maintain adequate ventilation when using cutting torches.
  - 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
  - 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
  - 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  - 10. Dispose of demolished items and materials promptly.

- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:
  - 1. Clean salvaged items.
  - 2. Pack or crate items after cleaning. Identify contents of containers.
  - 3. Store items in a secure area until delivery to Owner.
  - 4. Transport items to Owner's storage area designated by Owner.
  - 5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
  - 1. Clean and repair items to functional condition adequate for intended reuse.
  - 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
  - 3. Protect items from damage during transport and storage.
  - 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

### 3.06 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- D. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."
- E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.
  - 1. Remove existing roof membrane, flashings, copings, and roof accessories.
  - 2. Remove existing roofing system down to substrate.

### 3.07 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
  - 1. Do not allow demolished materials to accumulate on-site.

2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

### 3.08 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

**END OF SECTION 02 41 19**

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**SECTION 03 10 00****CONCRETE FORMING AND ACCESSORIES****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Form-facing material for cast-in-place concrete.
  - 2. Form liners.
  - 3. Shoring, bracing, and anchoring.

**1.02 DEFINITIONS**

- A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

**1.03 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review the following:
    - a. Special inspection and testing and inspecting agency procedures for field quality control.
    - b. Construction, movement, contraction, and isolation joints
    - c. Forms and form-removal limitations.
    - d. Shoring and reshoring procedures.
    - e. Anchor rod and anchorage device installation tolerances.

**1.04 ACTION SUBMITTALS**

- A. Product Data: For each of the following:
  - 1. Exposed surface form-facing material.
  - 2. Concealed surface form-facing material.
  - 3. Forms for cylindrical columns.
  - 4. Pan-type forms.
  - 5. Void forms.
  - 6. Form liners.
  - 7. Form ties.
  - 8. Waterstops.
  - 9. Form-release agent.

- B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
  - 1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
  - 2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.
    - a. Location of construction joints is subject to approval from the Engineer.
  - 3. Indicate location of waterstops.
  - 4. Indicate form liner layout and form line termination details.
  - 5. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.
  - 6. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.
- C. Samples:
  - 1. For waterstops.
  - 2. For Form Liners: 12-inch by 12-inch sample, indicating texture.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing and inspection agency.
- B. Research Reports: For insulating concrete forms indicating compliance with International Code Council Acceptance Criteria AC308.
- C. Field quality-control reports.
- D. Minutes of preinstallation conference.

#### 1.06 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Form Liners: Store form liners under cover to protect from sunlight.
- B. Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.
- C. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
  - 1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
  - 2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

### 2.02 FORM-FACING MATERIALS

- A. As-Cast Surface Form-Facing Material:
  - 1. Provide continuous, true, and smooth concrete surfaces.
  - 2. Furnish in largest practicable sizes to minimize number of joints.
  - 3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete, and as follows:
    - a. Plywood, metal, or other approved panel materials.
    - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
      - 1) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
- B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
  - 1. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces without spiral or vertical seams not exceeding specified formwork surface class.
  - 1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation, with straight or tapered end forms.
- E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- F. Form Liners:
  - 1. Spec Formliners, Inc. or Approved Equal.
  - 2. Size: 4'x10'.
  - 3. Face Pattern: Per Architectural Requirements.

## 2.03 WATERSTOPS

- A. Flexible Rubber Waterstops: U.S. Army Corps of Engineers CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints, with factory fabricated corners, intersections, and directional changes.
  - 1. W.R. Meadows or Approved Equal.
  - 2. Profile: As indicated.
  - 3. Dimensions: As indicated.
- B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals, with factory fabricate corners, intersections, and directional changes.
  - 1. SIKA or Approved Equal.
  - 2. Profile: As indicated.
  - 3. Dimensions: As indicated.
- C. Flexible PVC Waterstops: U.S. Army Corps of Engineers CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints, with factory fabricate corners, intersections, and directional changes.
  - 1. W.R. Meadows or Approved Equal.
  - 2. Profile: As indicated.
  - 3. Dimensions: As indicated.
- D. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.
  - 1. SIKA or Approved Equal.
- E. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.
  - 1. SIKA or Approved Equal.

## 2.04 RELATED MATERIALS

- A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
  2. Form release agent for form liners shall be acceptable to form liner manufacturer.
- F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
  2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
  3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION OF FORMWORK**

- A. Comply with ACI 301.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete" for as-cast finishes.
- C. Limit concrete surface irregularities as follows:
1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
  2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
  3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
1. Minimize joints.
  2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
  2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  3. Install keyways, reglets, recesses, and other accessories, for easy removal.
- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
1. Provide and secure units to support screed strips
  2. Use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
  2. Locate temporary openings in forms at inconspicuous locations.
- I. Chamfer exterior corners and edges of permanently exposed concrete.
- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
1. Determine sizes and locations from trades providing such items.
  2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
- L. Construction and Movement Joints:
1. Construct joints true to line with faces perpendicular to surface plane of concrete.
  2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  3. Place joints perpendicular to main reinforcement.
  4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
    - a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  6. Space vertical joints in walls as indicated on Drawings.
    - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
  2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
- N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.02 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

### 3.03 INSTALLATION OF WATERSTOPS

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.
1. Install in longest lengths practicable.
  2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
  3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 03 30 00 "Cast-In-Place Concrete."
  4. Secure waterstops in correct position at 12 inches on center.
  5. Field fabricate joints in accordance with manufacturer's instructions using heat welding.
    - a. Miter corners, intersections, and directional changes in waterstops.
    - b. Align center bulbs.
  6. Clean waterstops immediately prior to placement of concrete.
  7. Support and protect exposed waterstops during progress of the Work.
- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.
1. Install in longest lengths practicable.
  2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
  3. Protect exposed waterstops during progress of the Work.

### 3.04 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
  2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work.
1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.

2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
  1. Align and secure joints to avoid offsets.
  2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

### 3.05 SHORING AND RESHORING INSTALLATION

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
  1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

### 3.06 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
  1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
  2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

**END OF SECTION 03 10 00**



**SECTION 03 20 00**  
**CONCRETE REINFORCING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
1. Steel reinforcement bars.
  2. Welded-wire reinforcement.

**1.02 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
1. Review the following:
    - a. Special inspection and testing and inspecting agency procedures for field quality control.
    - b. Construction contraction and isolation joints.
    - c. Steel-reinforcement installation.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For the following:
1. Each type of steel reinforcement.
  2. Epoxy repair coating.
  3. Zinc repair material.
  4. Bar supports.
  5. Mechanical splice couplers.
- B. Shop Drawings: Comply with ACI SP-066:
1. Include placing drawings that detail fabrication, bending, and placement.
  2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
- C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
1. Location of construction joints is subject to approval of Architect **and Engineer of Record**.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For delegated design engineer.
- B. Delegated Design Engineer Qualifications: Include the following:
  - 1. Experience providing delegated design engineering services of the type indicated.
  - 2. Documentation that delegated design engineer is licensed in the state in which Project is located.
- C. Welding certificates.
  - 1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.
- D. Material Test Reports: For the following, from a qualified testing agency:
  - 1. Steel Reinforcement:
    - a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
  - 2. Mechanical splice couplers.
- E. Field quality-control reports.
- F. Minutes of preinstallation conference.

#### 1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage and to avoid damaging coatings on steel reinforcement.
  - 1. Store reinforcement to avoid contact with earth.
  - 2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
  - 3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
  - 4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

## PART 2 - PRODUCTS

### 2.01 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.
- C. Headed-Steel Reinforcing Bars: ASTM A970/A970M.
- D. Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60 (Grade 420), deformed bars, assembled with clips.
- E. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- F. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
- G. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.
- H. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A coated, Type 1, plain deformed steel.

### 2.02 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, ASTM A775/A775M epoxy coated.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
  - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
    - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
    - b. For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
    - c. For dual-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
    - d. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
    - e. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- D. Mechanical Splice Couplers: ACI 318 (ACI 318M) Type 1 Type 2, same material of reinforcing bar being spliced; compression-only type tension-compression type dowel-bar type mechanical-lap type.

- E. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.
  - 1. Finish: Plain Galvanized ASTM A884/A884M, Class A, Type 1, epoxy coated, with less than 2 percent damaged coating in each 12-inch wire length.
- F. Stainless Steel Tie Wire: ASTM A1022/A1022M, not less than 0.0508 inch in diameter.

## 2.03 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Protection of In-Place Conditions:
  - 1. Do not cut or puncture vapor retarder.
  - 2. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

### 3.02 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
  - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
  - 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
  - 1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
  - 2. Stagger splices in accordance with ACI 318.
  - 3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
  - 4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.
- G. Install welded-wire reinforcement in longest practicable lengths.
  - 1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

- a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches.
2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

### 3.03 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  1. Place joints perpendicular to main reinforcement.
  2. Continue reinforcement across construction joints unless otherwise indicated.
  3. Do not continue reinforcement through sides of strip placements of floors and slabs.
- B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

### 3.04 INSTALLATION TOLERANCES

- A. Comply with ACI 117.

### 3.05 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
  1. Steel-reinforcement placement.
  2. Steel-reinforcement mechanical splice couplers.
  3. Steel-reinforcement welding.
- D. Manufacturer's Inspections: Engage manufacturer of structural thermal break insulated connection system to inspect completed installations prior to placement of concrete, and to provide written report that installation complies with manufacturer's written instructions.

**END OF SECTION 03 20 00**

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**SECTION 03 30 00**  
**CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

**B. Related Requirements:**

1. Section 03 10 00 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 03 20 00 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 31 20 00 "Earth Moving" for drainage fill under slabs-on-ground.

**1.02 DEFINITIONS**

- A. Cementitious Materials:** Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

- B. Water/Cement Ratio (w/cm):** The ratio by weight of water to cementitious materials.

**1.03 PREINSTALLATION MEETINGS**

**A. Preinstallation Conference:** Conduct conference at Project site .

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

- a. Contractor's superintendent.
- b. Independent testing agency responsible for concrete design mixtures.
- c. Ready-mix concrete manufacturer.
- d. Concrete Subcontractor.
- e. Special concrete finish Subcontractor.

2. Review the following:

- a. Special inspection and testing and inspecting agency procedures for field quality control.
- b. Construction joints, control joints, isolation joints, and joint-filler strips.
- c. Semirigid joint fillers.
- d. Vapor-retarder installation.

- e. Anchor rod and anchorage device installation tolerances.
- f. Cold and hot weather concreting procedures.
- g. Concrete finishes and finishing.
- h. Curing procedures.
- i. Forms and form-removal limitations.
- j. Concrete repair procedures.
- k. Concrete protection.
- l. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
- m. Protection of field cured field test cylinders.

#### 1.04 ACTION SUBMITTALS

A. Product Data: For each of the following.

- 1. Portland cement.
- 2. Fly ash.
- 3. Slag cement.
- 4. Blended hydraulic cement.
- 5. Silica fume.
- 6. Performance-based hydraulic cement
- 7. Aggregates.
- 8. Admixtures:
  - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
- 9. Vapor retarders.
- 10. Floor and slab treatments.
- 11. Liquid floor treatments.
- 12. Curing materials.
  - a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
- 13. Joint fillers.
- 14. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

- 1. Mixture identification.
- 2. Minimum 28-day compressive strength.
- 3. Durability exposure class.
- 4. Maximum w/cm.
- 5. Calculated equilibrium unit weight, for lightweight concrete.
- 6. Slump limit.
- 7. Air content.
- 8. Nominal maximum aggregate size.
- 9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
- 10. Intended placement method.
- 11. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- 12. 30-day compression strength test history.



13. Design mix to be prepared, signed and stamped by a professional engineer registered in State of Arkansas.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
  - a. Location of construction joints is subject to approval of the Architect and Engineer of Record.

D. Samples: For manufacturer's standard colors for color pigment vapor retarder.

E. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Vapor retarders.
9. Semirigid joint filler.
10. Joint-filler strips.
11. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement.

- 7. Aggregates.
- 8. Admixtures:
  - a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

- D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.
- E. Research Reports:
  - 1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
  - 2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.
- F. Preconstruction Test Reports: For each mix design.
- G. Field quality-control reports.
- H. Minutes of preinstallation conference.

#### 1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician with experience installing and finishing concrete, incorporating permeability-reducing admixtures.
  - 1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.
- B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
  - 1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
  - 1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Field Quality-Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
  - 1. Personnel conducting field tests to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

#### 1.07 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
  - 1. Include the following information in each test report:
    - a. Admixture dosage rates.
    - b. Slump.
    - c. Air content.
    - d. Seven-day compressive strength.
    - e. 28-day compressive strength.
    - f. Permeability.

#### 1.08 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and ACI 301.

#### 1.09 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.
  - 1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  - 3. Do not use frozen materials or materials containing ice or snow.
  - 4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
  - 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
  - 1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
  - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

#### 1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.
  - 1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.
- B. Source Limitations:
  - 1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
  - 2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
  - 3. Obtain aggregate from single source.
  - 4. Obtain each type of admixture from single source from single manufacturer.
- C. Cementitious Materials:
  - 1. Portland Cement: ASTM C150/C150M, Type I/II, gray.
  - 2. Fly Ash: ASTM C618, Class C or F.
  - 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
  - 4. Silica Fume: ASTM C1240 amorphous silica.
- D. Normal-Weight Aggregates: ASTM C33/C33M, coarse aggregate or better, graded. Provide aggregates from a single source.
  - 1. Alkali-Silica Reaction: Comply with one of the following:
    - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
    - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
    - c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.
  - 2. Maximum Coarse-Aggregate Size: 1 inch nominal.
  - 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- E. Air-Entraining Admixture: ASTM C260/C260M.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.
  - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
  - 2. Retarding Admixture: ASTM C494/C494M, Type B.
  - 3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  - 5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
  - 7. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing

chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.

8. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

- G. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments, color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

1. Color: As indicated by manufacturer's designation Match Architect's sample As selected by Architect from manufacturer's full range.

- H. Water and Water Used to Make Ice: ASTM C94/C94M, potable or complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4

## 2.02 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A, except with maximum water-vapor permeance of 0.10; not less than 15 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

## 2.03 FLOOR AND SLAB TREATMENTS

- A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing 3/8-inch No. 4 No. 8 sieve.
- B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.
- C. Emery Dry-Shake Floor Hardener: Pigmented Unpigmented, factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.
  1. Color: As indicated by manufacturer's designation Match Architect's sample As selected by Architect from manufacturer's full range.
- D. Metallic Dry-Shake Floor Hardener: Pigmented Unpigmented, factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.
  1. Color: As indicated by manufacturer's designation Match Architect's sample As selected by Architect from manufacturer's full range.
- E. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.
- F. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Color: As indicated by manufacturer's designation Match Architect's sample As selected by Architect from manufacturer's full range.

#### 2.04 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

#### 2.05 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
  1. Color:
    - a. Ambient Temperature Below 50 deg F: Black.
    - b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
    - c. Ambient Temperature Above 85 deg F: White.
- D. Curing Paper: 8-feet- wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.
- E. Water: Potable or complying with ASTM C1602/C1602M.
- F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.
- G. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B, certified by curing compound manufacturer to not interfere with bonding of floor covering.
- H. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
- I. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
- J. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

#### 2.06 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.

- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 in accordance with ASTM D2240.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:
  - 1. Types I and II, nonload bearing Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Floor Slab Protective Covering: 8-feet- wide cellulose fabric.

## 2.07 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
  - 4. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
  - 4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

## 2.08 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
  - 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, and concrete with a w/cm below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

## 2.09 CONCRETE MIXTURES

A. Normal-weight concrete for all uses unless indicated otherwise.

1. Exposure Class: ACI 318 F1 or C1.
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Maximum w/cm: 0.40.
4. Slump Limit: 5 inches, plus or minus 1 inch .
5. Air Content:
  - a. Exposure Class F1: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size and 4.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size.
6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

## 2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and ASTM C1116/C1116M, and furnish batch ticket information.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..



3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Verification of Conditions:
  1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
  2. Do not proceed until unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
  1. Daily access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
  4. Security and protection for test samples and for testing and inspection equipment at Project site.

### 3.03 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
  1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
  3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

### 3.04 INSTALLATION OF VAPOR RETARDER

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
  1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
  2. Face laps away from exposed direction of concrete pour.
  3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.

4. Lap joints 6 inches and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.

- a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

- B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

### 3.05 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.
  - a. Continue reinforcement across construction joints unless otherwise indicated.
  - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 07 92 00 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

### 3.06 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
  - a. Do not use vibrators to transport concrete inside forms.
  - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
  - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.

- d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
- 1. Do not place concrete floors and slabs in a checkerboard sequence.
  - 2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 3. Maintain reinforcement in position on chairs during concrete placement.
  - 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
  - 5. Level concrete, cut high areas, and fill low areas.
  - 6. Slope surfaces uniformly to drains where required.
  - 7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
  - 8. Do not further disturb slab surfaces before starting finishing operations.

### 3.07 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

- 1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
  - a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
  - b. Remove projections larger than 1 inch.
  - c. Tie holes do not require patching.
  - d. Surface Tolerance: ACI 117 Class D.
  - e. Apply to concrete surfaces not exposed to public view As indicated.
- 2. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
  - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
  - b. Remove projections larger than 1/4 inch.
  - c. Patch tie holes.
  - d. Surface Tolerance: ACI 117 Class B.
  - e. Locations: Apply to concrete surfaces or to be covered with a coating or covering material applied directly to concrete As indicated.
- 3. ACI 301 Surface Finish SF-3.0:
  - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
  - b. Remove projections larger than 1/8 inch.
  - c. Patch tie holes.
  - d. Surface Tolerance: ACI 117 Class A.
  - e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete As indicated.

B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:

- 1. Smooth-Rubbed Finish:

- a. Perform no later than one day after form removal.
- b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
- c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
- d. Maintain required patterns or variances as shown on Drawings or to match design reference sample.

2. Grout-Cleaned Rubbed Finish:

- a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
- b. Do not clean concrete surfaces as Work progresses.
- c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
- d. Wet concrete surfaces.
- e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
- f. Maintain required patterns or variances as shown on Drawings or to match design reference sample.

3. Cork-Floated Finish:

- a. Mix 1 part portland cement to 1 part fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint.
- b. Mix 1 part portland cement and 1 part fine sand with sufficient water to produce a mixture of stiff grout. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
- c. Wet concrete surfaces.
- d. Compress grout into voids by grinding surface.
- e. In a swirling motion, finish surface with a cork float.
- f. Maintain required patterns or variances as shown on Drawings or to match design reference sample.

4. Scrubbed Finish: After concrete has achieved a compressive strength of from 1000 to 1500 psi, apply scrubbed finish.

- a. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed.
- b. Rinse scrubbed surfaces with clean water.
- c. Maintain continuity of finish on each surface or area of Work.
- d. Remove only enough concrete mortar from surfaces to match design reference sample.

C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi.
2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
3. Surface Continuity:
  - a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.

- b. Maintain required patterns or variances in depths of blast to match design reference sample .
- 4. Abrasive Blasting:
  - a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
  - b. Determine type of nozzle pressure and blasting techniques required to match field sample.
  - c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:
    - 1) Brush Texture: Remove cement matrix to dull surface sheen and expose face of fine aggregate, with no significant reveal.
    - 2) Light Texture: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color, with maximum reveal of 1/16 inch.
    - 3) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of 1/4 inch.
    - 4) Heavy Texture: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter, with reveal range of 1/4 to 1/2 inch.
  - d. Maintain required patterns or variances in reveal projection to match design reference sample.
- D. High-Pressure Water-Jet Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
  - 1. Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi.
  - 2. Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
  - 3. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
  - 4. Maintain required patterns or variances in reveal projection to match design reference sample.
- E. Bushhammer Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
  - 1. Perform bushhammer finish to concrete that has achieved a minimum compressive strength of 4500 psi.
  - 2. Surface Continuity:
    - a. Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
  - 3. Surface Cut:
    - a. Maintain required depth of cut and general aggregate exposure.
    - b. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.
  - 4. Remove impressions of formwork and form facings with exception of tie holes.
  - 5. Maintain required patterns or variances of cut as shown on Drawings or to match design reference sample.

6. Maintain control of concrete chips, dust, and debris in each Work area, limiting migration of airborne materials and dust by use of tarpaulins, wind-breaks, or similar devices.

F. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.08 FINISHING FLOORS AND SLABS

- A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
3. Apply scratch finish to surfaces to receive concrete floor toppings to receive mortar setting As indicated.

C. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo As indicated.

D. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces coating system As indicated.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

a. Slabs on Ground:

- 1) Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.- long straightedge resting on two high spots

and placed anywhere on the surface does not exceed 1/4 inch 3/16 inch 1/8 inch 1/8 inch and also no more than 1/16 inch in 2 feet.

- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated on Drawings where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
  - 1. Coordinate required final finish with Architect before application.
  - 2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.
  - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
  - 2. Coordinate required final finish with Architect before application.
- G. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate aluminum granule finish to concrete stair treads, platforms, ramps as indicated on Drawings
  - 1. Apply in accordance with manufacturer's written instructions and as follows:
    - a. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate aluminum granules over surface in one or two applications.
    - b. Tamp aggregate flush with surface, but do not force below surface.
    - c. After broadcasting and tamping, apply float finish.
    - d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate aluminum granules.
- H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces in accordance with manufacturer's written instructions and as follows:
  - 1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer.
  - 2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating.
  - 3. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
  - 4. After final floating, apply a trowel finish.
  - 5. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

### 3.09 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

- A. Filling In:
  - 1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
  - 2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
  - 3. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.



C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 6 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
  - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - b. Cast anchor-bolt insert into bases.
  - c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

3.10 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305.1, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
  - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
  - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
  - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
  - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
  - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

- 1) Recoat areas subject to heavy rainfall within three hours after initial application.
- 2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:
  - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
    - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
      - a) Lap edges and ends of absorptive cover not less than 12 inches.
      - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than ten days.
    - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
      - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
      - b) Cure for not less than ten days.
    - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than ten days, utilizing one, or a combination of, the following:
      - a) Water.
      - b) Continuous water-fog spray.
  - b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
    - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
      - a) Lap edges and ends of absorptive cover not less than 12 inches.
      - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than ten days.
    - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
      - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
      - b) Cure for not less than ten days.

- 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than ten days, utilizing one, or a combination of, the following:
  - a) Water.
  - b) Continuous water-fog spray.
- c. Floors to Receive Polished Finish: Contractor has option of the following:
  - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
    - a) Lap edges and ends of absorptive cover not less than 12 inches.
    - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than ten days.
  - 2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than ten days, utilizing one, or a combination of, the following:
    - a) Water.
    - b) Continuous water-fog spray.
- d. Floors to Receive Chemical Stain:
  - 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
  - 2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
  - 3) Butt sides of curing paper tight; do not overlap sides of curing paper.
  - 4) Leave curing paper in place for duration of curing period, but not less than 28 days.
- e. Floors to Receive Urethane Flooring:
  - 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
  - 2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
  - 3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
  - 4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.
- f. Floors to Receive Curing Compound:
  - 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
  - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
  - 3) Maintain continuity of coating, and repair damage during curing period.
  - 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound

manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

g. Floors to Receive Curing and Sealing Compound:

- 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

### 3.11 TOLERANCES

- A. Conform to ACI 117.

### 3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.
1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
  2. Do not apply to concrete that is less than ten days' old.
  3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
  4. Rinse with water; remove excess material until surface is dry.
  5. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

### 3.13 JOINT FILLING

- A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.
1. Defer joint filling until concrete has aged at least one month(s).
  2. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.
- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

### 3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
  2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
    - a. Limit cut depth to 3/4 inch.
    - b. Make edges of cuts perpendicular to concrete surface.
    - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
    - d. Fill and compact with patching mortar before bonding agent has dried.
    - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
    - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
    - b. Compact mortar in place and strike off slightly higher than surrounding surface.
  3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces:
1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
    - a. Correct low and high areas.
    - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  3. After concrete has cured at least 14 days, correct high areas by grinding.
  4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
    - a. Finish repaired areas to blend into adjacent concrete.
  5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
    - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    - b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.
  - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
  - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
  - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
  - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
  - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
  - d. Place, compact, and finish to blend with adjacent finished concrete.
  - e. Cure in same manner as adjacent concrete.
8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
  - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
  - b. Dampen cleaned concrete surfaces and apply bonding agent.
  - c. Place patching mortar before bonding agent has dried.
  - d. Compact patching mortar and finish to match adjacent concrete.
  - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.15 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Owner will engage Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
  1. Testing agency to be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
  2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
  3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
    - a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
      - 1) Project name.
      - 2) Name of testing agency.

- 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
  - 4) Name of concrete manufacturer.
  - 5) Date and time of inspection, sampling, and field testing.
  - 6) Date and time of concrete placement.
  - 7) Location in Work of concrete represented by samples.
  - 8) Date and time sample was obtained.
  - 9) Truck and batch ticket numbers.
  - 10) Design compressive strength at 28 days.
  - 11) Concrete mixture designation, proportions, and materials.
  - 12) Field test results.
  - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
  - 14) Type of fracture and compressive break strengths at seven days and 28 days.
- C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- D. Inspections:
1. Headed bolts and studs.
  2. Verification of use of required design mixture.
  3. Concrete placement, including conveying and depositing.
  4. Curing procedures and maintenance of curing temperature.
  5. Verification of concrete strength before removal of shores and forms from beams and slabs.
  6. Batch Plant Inspections: On a random basis, as determined by Architect.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
    - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  2. Slump: ASTM C143/C143M:
    - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    - b. Perform additional tests when concrete consistency appears to change.
  3. Slump Flow: ASTM C1611/C1611M:
    - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    - b. Perform additional tests when concrete consistency appears to change.
  4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; ASTM C173/C173M volumetric method, for structural lightweight concrete.

- a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M:
  - a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
  - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C31/C31M:
  - a. Cast and laboratory cure two sets of four 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
  - b. Cast, initial cure, and field cure two sets of four standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C39/C39M.
  - a. Test one set of four laboratory-cured specimens at seven days and one set of two specimens at 28 days.
  - b. Test one set of four field-cured specimens at seven days and one set of two specimens at 28 days.
  - c. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests:
  - a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
  - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
    - 1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.6.6.3.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.



14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 72 hours of completion of floor finishing and promptly report test results to Architect.

### 3.16 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

**END OF SECTION**

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**SECTION 05 12 00****STRUCTURAL STEEL FRAMING****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Structural steel.
2. Shear stud connectors, shop and field welded.

**B. Related Requirements:**

1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel fabrications and other steel items not defined as structural steel.
2. Section 09 91 23 "Interior Painting" and Section 09 96 00 "High-Performance Coatings" for painting requirements.

**1.02 DEFINITIONS**

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

**1.03 COORDINATION**

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

**1.04 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

**1.05 ACTION SUBMITTALS****A. Product Data:**

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Shear stud connectors.
4. Anchor rods.

5. Threaded rods.
6. Forged-steel hardware.
7. Shop primer.
8. Galvanized-steel primer.
9. Etching cleaner.
10. Galvanized repair paint.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members not to be shop primed.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

#### 1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and fabricator.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural-steel materials, including chemical and physical properties.
- E. Product Test Reports: For the following:
  1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
  2. Direct-tension indicators.
  3. Tension-control, high-strength, bolt-nut-washer assemblies.
  4. Shear stud connectors.
- F. Survey of existing conditions.
- G. Source quality-control reports.

#### 1.07 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
  - 1. Welders and welding operators performing work on bottom-flange, demand-critical welds are to pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G are to be considered separate processes for welding personnel qualification.

#### 1.08 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
  - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
  - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
  - 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
  - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
  - 1. ANSI/AISC 303.
  - 2. ANSI/AISC 360.
  - 3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:
  - 1. Option 1: Connection designs have been completed and connections indicated on the Drawings.

#### 2.02 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M.
- A. Channels, Angles, M-Shapes: ASTM A36/A36M.

- B. Plate and Bar: ASTM A36/A36M.
- C. Corrosion-Resisting (Weathering) Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, 50 ksi.
- D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B structural tubing.
- E. Corrosion-Resisting (Weathering), Cold-Formed Hollow Structural Sections: ASTM A847/A847M structural tubing.
- F. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
  - 1. Weight Class: Standard.
  - 2. Finish: Black except where indicated to be galvanized.
- G. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.
- H. Steel Forgings: ASTM A668/A668M.
- I. Welding Electrodes: Comply with AWS requirements.

## 2.03 BOLTS AND CONNECTORS

- A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
  - 1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with plain finish.
- B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
  - 1. Direct-Tension Indicators: ASTM F959/F959M, Type 490-1, compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
  - 1. Finish: Hot-dip zinc coating.
  - 2. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with mechanically deposited zinc coating finish.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, round head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
  - 1. Finish: Plain.

- E. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

## 2.04 RODS

- A. Unheaded Anchor Rods: ASTM F1554, Grade 36.
  - 1. Configuration: Straight.
  - 2. Nuts: ASTM A563 heavy-hex carbon steel.
  - 3. Plate Washers: ASTM A36/A36M carbon steel.
  - 4. Washers: ASTM F436, Type 1, hardened carbon steel.
  - 5. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.
- B. Headed Anchor Rods: ASTM F1554, Grade 36 ASTM F1554, Grade 55, weldable, straight.
  - 1. Nuts: ASTM A563 hex carbon steel.
  - 2. Plate Washers: ASTM A36/A36M carbon steel.
  - 3. Washers: ASTM F436, Type 1, hardened carbon steel.
  - 4. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.
- C. Threaded Rods: ASTM A36/A36M ASTM A572/A572M, Grade 50.
  - 1. Nuts: ASTM A63 hex carbon steel.
  - 2. Washers: ASTM F436, Type 1, hardened carbon steel.
  - 3. Finish: Plain.

## 2.05 FORGED-STEEL STRUCTURAL HARDWARE

- A. Clevises and: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1035.
- B. Eye Bolts and Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1030.
- C. Sleeve Nuts: Made from cold-finished carbon-steel bars, ASTM A108, AISI C-1018.

## 2.06 PRIMER

- A. Steel Primer:
  - 1. Comply with Section 09 91 23 "Interior Painting," and Section 09 96 00 "High-Performance Coatings" for exterior application
  - 2. SSPC-Paint 23, latex primer.
  - 3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Galvanized-Steel Primer: MPI#134.
  - 1. Etching Cleaner: MPI#25, for galvanized steel.
  - 2. Galvanizing Repair Paint: ASTM A780/A780M.

## 2.07 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
  - 1. Camber structural-steel members where indicated.
  - 2. Fabricate beams with rolling camber up.
  - 3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
  - 4. Mark and match-mark materials for field assembly.
  - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
  - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 3.
- F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.
- H. Welded-Steel Door Frames: Build up welded-steel door frames attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated on Drawings.
- I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
  - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
  - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

## 2.08 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened.



- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  - 1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

## 2.09 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
  - 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
  - 2. Galvanize lintels shelf angles and welded door frames attached to structural-steel frame and located in exterior walls.

## 2.10 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  - 2. Surfaces to be field welded.
  - 3. Surfaces of high-strength bolted, slip-critical connections.
  - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
  - 5. Galvanized surfaces unless indicated to be painted.
  - 6. Corrosion-resisting (weathering) steel surfaces.
  - 7. Surfaces enclosed in interior construction.
- B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:
  - 1. SSPC-SP 2.
  - 2. SSPC-SP 3.
  - 3. SSPC-SP 7 (WAB)/NACE WAB-4.
  - 4. SSPC-SP 14 (WAB)/NACE WAB-8.
  - 5. SSPC-SP 11.
  - 6. SSPC-SP 6 (WAB)/NACE WAB-3.
  - 7. SSPC-SP 10 (WAB)/NACE WAB-2.
  - 8. SSPC-SP 5 (WAB)/NACE WAB-1.
  - 9. SSPC-SP 8.
- C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.
- D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

## 2.11 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.
1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
  2. Bolted Connections: Inspect and test shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
  3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    - a. Liquid Penetrant Inspection: ASTM E165/E165M.
    - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    - c. Ultrasonic Inspection: ASTM E164.
    - d. Radiographic Inspection: ASTM E94/E94M.
  4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with 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 stud connector.
    - b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.
  5. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

### 3.03 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
  1. Set plates for structural members on wedges, shims, or setting nuts as required.
  2. Weld plate washers to top of baseplate.
  3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
  4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
  2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

### 3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
  1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
  2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.

3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

- C. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

### 3.05 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

- A. Install prefabricated building columns to comply with ANSI/AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

### 3.06 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting:
  1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
    - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
  2. Cleaning and touchup painting are specified in Section 09 91 23 "Interior Painting." and Section 09 96 00 "High-Performance Coatings."
- C. Touchup Priming: Cleaning and touchup priming are specified in Section 09 96 00 "High-Performance Coatings."

### 3.07 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:
  1. Verify structural-steel materials and inspect steel frame joint details.
  2. Verify weld materials and inspect welds.
  3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
  2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
    - a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

- 1) Liquid Penetrant Inspection: ASTM E165/E165M.
  - 2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
  - 3) Ultrasonic Inspection: ASTM E164.
  - 4) Radiographic Inspection: ASTM E94/E94M.
3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-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.

**END OF SECTION 05 12 00**

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**SECTION 05 40 00****COLD-FORMED METAL FRAMING****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Load-bearing wall framing.
2. Ceiling joist framing.

**B. Related Requirements:**

1. Section 09 22 16 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

**1.02 PREINSTALLATION MEETINGS****A. Preinstallation Conference: Conduct conference at Project site.****1.03 ACTION SUBMITTALS****A. Product Data: For the following:**

1. Cold-formed steel framing materials.
2. Load-bearing wall framing.
3. Vertical deflection clips.
4. Single deflection track.
5. Double deflection track.
6. Drift clips.
7. Ceiling joist framing.
8. Post-installed anchors.
9. Power-actuated anchors.
10. Sill sealer gasket.
11. Sill sealer gasket/termite barrier.

**B. Shop Drawings:**

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

**1.04 INFORMATIONAL SUBMITTALS****A. Qualification Data: For testing agency.**

- B. Welding certificates.
- C. Product Certificates: For each type of code-compliance certification for studs and tracks.
- D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.
  - 1. Steel sheet.
  - 2. Expansion anchors.
  - 3. Power-actuated anchors.
  - 4. Mechanical fasteners.
  - 5. Vertical deflection clips.
  - 6. Horizontal drift deflection clips
  - 7. Miscellaneous structural clips and accessories.
- E. Research Reports:
  - 1. For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
  - 2. For sill sealer gasket/termite barrier, showing compliance with ICC-ES AC380.

#### 1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, the Steel Stud Manufacturers Association (ICC ESR-3064P), or the Supreme Steel Framing System Association.
- 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."

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI S202.



## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
  - 1. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
    - a. Interior Load-Bearing Wall Framing: Horizontal deflection of  $L/240$  of the wall height under a horizontal load of 5 lbf/sq. ft..
    - b. Ceiling Joist Framing: Vertical deflection of  $L/240$  of the span for live loads and  $L/240$  for total loads of the span.
- B. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and AISI S240.
- C. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

### 2.02 COLD-FORMED STEEL FRAMING MATERIALS

- A. Framing Members, General: Comply with AISI S240 for conditions indicated.
- B. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
  - 1. Grade: ST50H.
  - 2. Coating: G60, A60, AZ50, or GF30.
- C. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:
  - 1. Grade: 50, Class 1.
  - 2. Coating: G60.

### 2.03 LOAD-BEARING WALL FRAMING

- A. 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: 0.0538 inch.
  - 2. Minimum Flange Width: 1-5/8 inches.
- B. 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: Matching steel studs.
2. Minimum Flange Width: 1-1/4 inches.

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch.
2. Minimum Flange Width: 1-5/8 inches.

## 2.04 CEILING JOIST FRAMING

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch.
2. Flange Width: 1-5/8 inches, minimum.

## 2.05 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Gusset plates.
7. Stud kickers and knee braces.
8. Joist hangers and end closures.
9. Hole-reinforcing plates.
10. Backer plates.

## 2.06 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC193 as appropriate for the substrate.

1. Uses: Securing cold-formed steel framing to structure.
2. Type: Torque-controlled expansion anchor.

3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
  4. Material for Interior Locations Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.
- D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

## 2.07 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A780/A780M or SSPC-Paint 20.
- B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sill Sealer Gasket: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

## 2.08 FABRICATION

- A. Fabricate cold-formed steel framing 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.
1. Fabricate framing assemblies using jigs or templates.
  2. Cut framing members by sawing or shearing; do not torch cut.
  3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
    - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
  4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:
  - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.
  - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 PREPARATION**

- A. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.
- B. Install sill sealer gasket at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

#### **3.03 INSTALLATION, GENERAL**

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
  - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
  - 1. Cut framing members by sawing or shearing; do not torch cut.
  - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

- a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
  - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

### 3.04 INSTALLATION OF LOAD-BEARING WALL FRAMING

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
  - 1. Anchor Spacing: 32 inches.
- B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch between the end of wall-framing member and the web of track.
  - 1. Fasten both flanges of studs to top and bottom tracks.
  - 2. Space studs as follows:
    - a. Stud Spacing: As indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Align floor and ceiling framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.
- F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.
- G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
  - 1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.
  - 2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
  - 1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

- I. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

### 3.05 INSTALLATION OF JOIST FRAMING

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
  1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
  2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.
- C. Space joists not more than 2 inches from abutting walls, and as follows:
  1. Joist Spacing: As indicated on Drawings.
- D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.
- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.
  1. Install web stiffeners to transfer axial loads of walls above.
- F. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
- G. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

### 3.06 INSTALLATION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
  1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error are not to exceed minimum fastening requirements of sheathing or other finishing materials.

### 3.07 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

### 3.08 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### 3.09 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

**END OF SECTION**

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**SECTION 05 50 00****METAL FABRICATIONS****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Slotted channel framing.
4. Metal ladders.
5. Metal bollards.
6. Metal downspout boots.
7. Loose bearing and leveling plates for applications where they are not specified in other Sections.

**B. Products furnished, but not installed, under this Section include the following:**

1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

**C. Related Requirements:**

1. Section 05 12 00 "Structural Steel Framing" for steel framing, supports, and other steel items attached to the structural-steel framing.

**1.02 COORDINATION**

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

**1.03 ACTION SUBMITTALS****A. Product Data: For the following:**

1. Post-installed anchors.
2. Shop primers.

3. Shrinkage-resisting grout.
4. Slotted channel framing.
5. Manufactured metal ladders.
6. Metal bollards.
7. Metal downspout boots.

- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
1. Steel framing and supports for mechanical and electrical equipment.
  2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
  3. Metal ladders.
  4. Metal bollards.
- C. Delegated Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Research Reports: For post-installed anchors.

#### 1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

#### 1.06 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

## **PART 2 - PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer, licensed in the State of New Mexico, to design ladders.
- B. Structural Performance of Aluminum Ladders: Ladders, including landings, are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

### **2.02 METALS**

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 304.
- D. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.
- E. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- G. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
  - 1. Size of Channels: As indicated.
  - 2. Galvanized Steel: ASTM A653/A653M, structural steel, Grade 33, with G90 coating; 0.108-inch nominal thickness unless indicated otherwise.
- H. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.
- I. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.
- J. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.
- K. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.
- L. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

## 2.03 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
  - 1. Provide stainless steel fasteners for fastening aluminum and stainless steel.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 1.
- D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
  - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- F. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- G. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors as indicated.
  - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
  - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.
- H. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

## 2.04 MISCELLANEOUS MATERIALS

- A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- B. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- C. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- F. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 4000 psi.

## 2.05 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

## 2.06 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
  - 1. Fabricate units from slotted channel framing where indicated.
  - 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

## 2.07 METAL LADDERS

- A. General:
  - 1. Comply with ANSI A14.3.
- B. Aluminum Ladders:
  - 1. Source Limitations: Obtain aluminum ladders from single source from single manufacturer.
  - 2. Space siderails 18 inches apart unless otherwise indicated.
  - 3. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.
  - 4. Rungs: Extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.
  - 5. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.
  - 6. Provide platforms as indicated fabricated from pressure-locked aluminum bar grating extruded-aluminum plank grating, supported by extruded-aluminum framing. Limit openings in gratings to no more than 1/2 inch in least dimension.
  - 7. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted aluminum brackets.
  - 8. Provide minimum 72-inch- high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

## 2.08 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
  - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize and prime exterior miscellaneous steel trim.

- D. Prime exterior miscellaneous steel trim with zinc-rich primer.

## 2.09 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 80 steel pipe.
  - 1. Concrete fill bollards with 3000 psi concrete. Form domed top over steel pipe. Cover bollard with plastic yellow cover or paint yellow.

## 2.10 METAL DOWNSPOUT BOOTS

- A. Source Limitations: Obtain downspout boots from single source from single manufacturer.
- B. Provide downspout boots made from cast iron in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
  - 1. Outlet: Horizontal, to discharge into pipe.
- C. Prime cast-iron downspout boots with zinc-rich primer.

## 2.11 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize bearing and leveling plates.

## 2.12 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

## 2.13 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

## 2.14 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

- C. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
  - 1. Shop prime with universal shop primer unless zinc-rich primer is indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
  - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 3. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
  - 4. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

## 2.15 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.

## PART 3 - EXECUTION

### 3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.



- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
  - 1. Cast Aluminum: Heavy coat of bituminous paint.
  - 2. Extruded Aluminum: Two coats of clear lacquer.

### 3.02 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports securely to, and rigidly brace from, building structure.

### 3.03 INSTALLATION OF METAL BOLLARDS

- A. Fill bollards solidly with concrete and allow concrete to cure seven days before installing.
  - 1. Do not fill removable bollards with concrete.
  - 2. Form domed concrete top on metal pipe.
  - 3. Cover bollard with yellow plastic cover or paint yellow.
- B. Anchor bollards in concrete in formed or core-drilled holes not less than 42 inches deep and 3/4 inch larger than OD of bollard. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

### 3.04 INSTALLATION OF BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

### 3.05 REPAIRS

- A. Touchup Painting:
  - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
    - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

**END OF SECTION 05 50 00**

**SECTION 05 51 19****METAL GRATING STAIRS****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Industrial Class stairs with steel-grating treads.
2. Steel railings and guards attached to metal stairs.
3. Steel handrails attached to walls adjacent to metal stairs.

**1.02 COORDINATION**

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs, railings, and guards.
1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
  2. Deliver such items to Project site in time for installation.
- C. Coordinate locations of hanger rods and struts with other work so they do not encroach on required stair width and are within fire-resistance-rated stair enclosure.
- D. Schedule installation of railings and guards so wall attachments are made only to completed walls.
1. Do not support railings and guards temporarily by any means that do not satisfy structural performance requirements.

**1.03 ACTION SUBMITTALS****A. Product Data: For metal grating stairs and the following:**

1. Gratings.
2. Woven-wire mesh.
3. Welded-wire mesh.
4. Shop primer products.
5. Grout.

**B. Shop Drawings:**

1. Include plans, elevations, sections, details, and attachment to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.

3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the State in which Project is located.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

#### 1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification.
  1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
  2. Protect steel members and packaged materials from corrosion and deterioration.
  3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.
    - a. Repair or replace damaged materials or structures as directed.

## PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  1. Uniform Load: 100 lbf/sq. ft..
  2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
  3. Uniform and concentrated loads need not be assumed to act concurrently.
  4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
  5. Limit deflection of treads, platforms, and framing members to L/360.

- B. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails and Top Rails of Guards:
    - a. Uniform load of 50 lbf/ft. applied in any direction.
    - b. Concentrated load of 200 lbf applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
  2. Infill of Guards:
    - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
    - b. Infill load and other loads need not be assumed to act concurrently.
  3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
    - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- C. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. Component Importance Factor:.

## 2.02 METALS

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
- D. Steel Bars for Grating Treads: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.
- E. Steel Wire Rod for Grating Crossbars: ASTM A510/A510M.
- F. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
- G. Provide galvanized finish for exterior installations and where indicated.
- H. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.
- I. Cast-Abrasive Nosings: Cast iron, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.

## 2.03 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls.
  - 1. Select fasteners for type, grade, and class required.
- B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated and capable of withstanding design loads.
- C. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
  - 1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for exterior stairs.
- E. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
  - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
  - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

## 2.04 MISCELLANEOUS MATERIALS

- A. Welding Electrodes: Comply with AWS requirements.
- B. Shop Primers: Provide primers that comply with Section 09 96 00 "High-Performance Coatings."
- C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- D. Zinc-Rich Primer: Comply with SSPC-Paint 20, Type II, Level 2, and compatible with topcoat.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- G. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for exterior use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

## 2.05 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, railings, guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
  - 1. Join components by welding unless otherwise indicated.
  - 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs, railings, and guards in shop to greatest extent possible.
  - 1. Disassemble units only as necessary for shipping and handling limitations.
  - 2. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately.
  - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
  - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Weld exposed corners and seams continuously unless otherwise indicated.
  - 5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #4 - Good quality, uniform undressed weld with minimal splatter.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
  - 1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
  - 2. Locate joints where least conspicuous.
  - 3. Fabricate joints that are exposed to weather in a manner to exclude water.
  - 4. Provide weep holes where water may accumulate internally.

## 2.06 FABRICATION OF STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Industrial Class, unless more stringent requirements are indicated.
- B. Stair Framing:
  - 1. Fabricate stringers of steel channels.
    - a. Stringer Size: As indicated on Drawings.

- b. Provide closures for exposed ends of channel stringers.
    - c. Finish: Shop primed.
  - 2. Construct platforms and tread supports of steel channel headers and miscellaneous framing members as indicated on Drawings.
    - a. Provide closures for exposed ends of channel framing.
    - b. Finish: Shop primed.
  - 3. Weld stringers to headers; weld framing members to stringers and headers.
- C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
  - 1. Fabricate treads and platforms from welded steel grating with 1-1/2-by-3/16-inch bearing bars at 1-3/16 inch o.c. and crossbars at 4 inches o.c.
    - a. Surface: Serrated.
    - b. Finish: Galvanized.
  - 2. Fabricate grating platforms with nosing matching that on grating treads.
    - a. Secure grating to platform framing by welding.
- D. Risers: Open.
- E. Toe Plates: Provide toe plates around openings and at edge of open-sided floors and platforms, and at open ends and open back edges of treads.
  - 1. Material and Finish: Steel plate to match finish of other steel items.
  - 2. Fabricate to dimensions and details indicated.

## 2.07 FABRICATION OF STAIR RAILINGS AND GUARDS

- A. Comply with applicable requirements in Section 05 52 13 "Pipe and Tube Railings."
- B. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.
  - 1. Rails and Posts: 1-5/8-inch- diameter top and bottom rails and 1-1/2-inch- square posts.
- C. Welded Connections: Fabricate railings and guards with welded connections.
  - 1. Fabricate connections that are exposed to weather in a manner that excludes water.
    - a. Provide weep holes where water may accumulate internally.
  - 2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
  - 3. Weld all around at connections, including at fittings.
  - 4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 5. Obtain fusion without undercut or overlap.



6. Remove flux immediately.
  7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #4 - Good quality, uniform undressed weld with minimal splatter as shown in NAAMM AMP 521.
- D. Form changes in direction of railings and guards as follows:
1. As detailed.
  2. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.
  3. By inserting prefabricated elbow fittings of radius indicated.
- E. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required.
1. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- F. Close exposed ends of railing and guard members with prefabricated end fittings.
- G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.
1. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- H. Connect posts to stair framing by direct welding unless otherwise indicated.
- I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.
1. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
  2. Provide type of bracket with predrilled hole for exposed bolt anchorage and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.
- 2.08 FINISHES
- A. Finish metal stairs after assembly.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
  2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
1. Exterior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.
  1. For wall-mounted railings, verify locations of concealed reinforcement within gypsum board and plaster assemblies.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 INSTALLATION OF METAL STAIRS**

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.
  1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
  1. Grouted Baseplates: Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces.
    - a. Clean bottom surface of baseplates.
    - b. Set steel-stair baseplates on wedges, shims, or leveling nuts.
    - c. After stairs have been positioned and aligned, tighten anchor bolts.
    - d. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.
    - e. Promptly pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
      - 1) Neatly finish exposed surfaces; protect grout and allow to cure.
      - 2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints.
  1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Comply with requirements for welding in "Fabrication, General" Article.

### 3.03 INSTALLATION OF RAILINGS AND GUARDS

- A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.
  1. Space posts at spacing indicated or, if not indicated, as required by design loads.
  2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet.
  3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet.
  4. Secure posts, rail ends, and guard ends to building construction as follows:
    - a. Anchor posts to steel by welding to steel supporting members.
    - b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.
- B. Attach handrails to wall with wall brackets.
  1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
  2. Secure wall brackets to building construction as required to comply with performance requirements.

### 3.04 REPAIR

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 96 00 "High-Performance Coatings."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

**END OF SECTION**

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**SECTION 05 52 13**  
**PIPE AND TUBE RAILINGS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Steel railings.
- B. Related Requirements:
  - 1. Section 05 51 19 "Metal Grating Stairs" for steel tube railings associated with metal grating stairs.

**1.02 COORDINATION**

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

**1.03 ACTION SUBMITTALS**

- A. Product Data:
  - 1. Manufacturer's product lines of mechanically connected railings.
  - 2. Fasteners.
  - 3. Post-installed anchors.
  - 4. Shop primer.
  - 5. Intermediate coats and topcoats.
  - 6. Bituminous paint.
  - 7. Nonshrink, nonmetallic grout.
  - 8. Anchoring cement.
  - 9. Metal finishes.
  - 10. Paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.

- D. Samples for Verification: For each type of exposed finish required.
  - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
  - 2. Fittings and brackets.
  - 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
    - a. Show method of connecting and finishing members at intersections.
- E. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation and who is licensed in the State of Arkansas.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
- E. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

#### 1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

#### 1.07 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  - 1. Top Rails of Guards:
    - a. Uniform load of 50 lbf/ ft. applied in any direction.
    - b. Concentrated load of 200 lbf applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

### 2.02 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
  - 1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

### 2.03 STEEL RAILINGS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
  - 1. Provide galvanized finish for exterior installations and where indicated.
- C. Plates, Shapes, and Bars: ASTM A36/A36M.
- D. Cast Iron Fittings: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

### 2.04 FASTENERS

- A. Fastener Materials:
  - 1. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
  - 2. Finish exposed fasteners to match appearance, including color and texture, of railings.

- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
  - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
  - 2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
  - 3. Provide Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193.
  - 1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

## 2.05 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Shop Primers: Provide primers that comply with Section 09 91 23 "Interior Painting."
- E. Shop Primer for Galvanized Steel: Primer formulated for use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Intermediate Coats and Topcoats: Provide products that comply with Section 09 91 23 "Interior Painting."
- G. Bituminous Paint: Cold-applied asphalt emulsion, complying with ASTM D1187/D1187M.
- H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

## 2.06 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.



- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
  - 1. Clearly mark units for reassembly and coordinated installation.
  - 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
  - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
  - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water.
  - 1. Provide weep holes where water may accumulate.
  - 2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded or nonwelded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove flux immediately.
  - 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
  - 1. Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.
- J. Form changes in direction as follows:
  - 1. As detailed.
  - 2. By bending or by inserting prefabricated elbow fittings.
  - 3. By bending to smallest radius that will not result in distortion of railing member.
- K. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- L. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

- N. Flanges, Fittings, and Anchors: Provide flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
- O. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

## 2.07 STEEL AND IRON FINISHES

- A. Galvanized Railings:
  - 1. Hot-dip galvanize steel railings, including hardware, after fabrication.
  - 2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
  - 3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
  - 4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
  - 5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For galvanized railings, provide hot-dip galvanized fittings, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner and as follows.
  - 1. Comply with SSPC-SP 16.
- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.
- E. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
  - 1. Shop prime uncoated railings with primers specified in Section 09 91 23 "Interior Painting".

## PART 3 - EXECUTION

### 3.01 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
  - 1. Fit exposed connections together to form tight, hairline joints.
  - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
  - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
  - 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
  - 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
  - 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
  - 1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

### 3.02 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

### 3.03 ANCHORING POSTS

- A. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
  - 1. For steel railings, weld flanges to post and bolt to metal supporting surfaces.

### 3.04 ATTACHING RAILINGS

- A. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and connected to railing ends, using nonwelded connections.

### 3.05 REPAIR

- A. Touchup Painting:
  - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
    - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 91 23 "Interior Painting."

3.06 CLEANING

- A. Clean by washing thoroughly with clean water and soap and rinsing with clean water.

3.07 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

**END OF SECTION**

**SECTION 05 53 13****BAR GRATINGS****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Metal bar gratings.
2. Grating frames and supports.

**B. Related Requirements:**

1. Section 05 12 00 "Structural Steel Framing" for structural-steel framing system components.
2. Section 05 51 19 "Metal Grating Stairs" for grating treads and landings of steel-framed stairs.
3. Section 05 52 13 "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

**1.02 ACTION SUBMITTALS****A. Product Data:**

1. Clips and anchorage devices for gratings.
2. Paint products.

**B. Shop Drawings:**

1. Include plans, sections, and attachment details.
2. Signed and sealed by the qualified professional engineer responsible for their preparation and who is licensed in the State of Arkansas.

**1.03 INFORMATIONAL SUBMITTALS****A. Coordination Drawings:** Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.**B. Certificates:**

1. Mill Certificates: Signed by manufacturers of stainless steel certifying that products furnished comply with requirements.
2. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
3. Welding certificates.

#### 1.04 QUALITY ASSURANCE

##### A. Qualifications:

1. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:
  - a. AWS D1.1/D1.1M.

#### 1.05 FIELD CONDITIONS

- ##### A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- ##### A. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Walkways and Elevated Platforms Other Than Exits: Uniform load of 100 lbf/sq. ft..
  2. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft..
  3. Limit deflection to L/360 or 1/4 inch, whichever is less.
- ##### B. Seismic Performance: Gratings to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
1. Component Importance Factor: 1.5.

#### 2.02 METAL BAR GRATINGS

- ##### A. Metal Bar Grating Standards: Comply with NAAMM MBG 531.
- ##### B. Welded Steel Grating :
1. Grating Mark W-19-4 (1-1/2 x 3/16) STEEL: 1-1/2-by-3/16-inch bearing bars at 1-3/16 inches o.c., and crossbars at 4 inches o.c.
  2. Traffic Surface: Serrated.
  3. Steel Finish: Shop primed.

#### 2.03 GRATING FRAMES AND SUPPORTS

- ##### A. Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
1. Unless otherwise indicated, fabricate from same basic metal as gratings.

2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

B. Galvanize steel frames and supports in the following locations:

1. Exterior.

## 2.04 FASTENERS

- A. General: Unless otherwise indicated, provide stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
  1. Provide stainless steel fasteners for fastening aluminum.
  2. Provide stainless steel fasteners for fastening stainless steel.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563, and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563, and, where indicated, flat washers.
  1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- D. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
  1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

## 2.05 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 09 96 00 "High-Performance Coatings."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.06 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.
- C. Wire Rod for Bar Grating Crossbars: ASTM A510/A510M.
- D. Uncoated Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 30.
- E. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, Grade 33, with G90 coating.

## 2.07 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Welding: Comply with AWS recommendations and the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
- F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
  - 1. Fabricate toeplates to fit grating units and weld to units in shop unless otherwise indicated.
  - 2. Fabricate toeplates for attaching in the field.
  - 3. Toeplate Height: 4 inches unless otherwise indicated.
- G. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
  - 1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
- H. Do not notch bearing bars at supports to maintain elevation.



## 2.08 STEEL FINISHES

- A. Finish gratings, frames, and supports after assembly.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- C. Shop prime gratings, frames, and supports not indicated to be galvanized unless otherwise indicated.
  - 1. Shop prime with primers specified in Section 09 96 00 "High-Performance Coatings" are indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 3. Items Indicated to Receive Primers Specified in Section 09 96 00 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 4. Other Items: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

## PART 3 - EXECUTION

### 3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
- D. Fit exposed connections accurately together to form hairline joints.
  - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. Attach toeplates to gratings by welding at locations indicated.

- F. Field Welding: Comply with AWS recommendations and the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
- G. Corrosion Protection: With a heavy coat of bituminous paint, coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals.

### 3.02 INSTALLATION OF METAL BAR GRATINGS

- A. Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
- C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

### 3.03 REPAIR

- A. Repair Painting:
  - 1. Wire brush and clean rust spots, welds, and abraded areas on prime-painted gratings immediately after installation, and apply repair paint with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
    - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
  - 2. Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- B. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

**END OF SECTION**

**SECTION 06 10 53****MISCELLANEOUS ROUGH CARPENTRY****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
1. Roof curbs cants and perimeter nailers.
  2. Plywood decking.
  3. Telephone and electrical panel backboards.
  4. Preservative treatment of wood.

**1.02 REFERENCE STANDARDS**

- A. American Wood Protection Association:
1. AWP M4 - Standard for the Care of Preservative-Treated Wood Products.
  2. AWP U1 - Use Category System: User Specification for Treated Wood.
- B. ASTM International:
1. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  2. ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- C. California Department of Health Services:
1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.
- D. U.S. Department of Commerce National Institute of Standards and Technology:
1. DOC PS 1 - Construction and Industrial Plywood.
  2. DOC PS 2 - Performance Standard for Wood-Based Structural-Use Panels.
  3. DOC PS 20 - American Softwood Lumber Standard.
- E. West Coast Lumber Inspection Bureau:
1. WCLIB - Standard Grading Rules for West Coast Lumber.
- F. Western Wood Products Association:
1. WWP 2011 Western Lumber Grade Rules, including supplements.

### 1.03 SUBMITTALS

- A. Product Data: Submit technical data and application instructions on wood-preservative and fire-retardant treatment materials.

### 1.04 QUALITY ASSURANCE

- A. Perform Work according to following:
  - 1. Lumber Grading Agency: Certified by DOC PS 20.
  - 2. Wood Structural Panel Grading Agency: Certified by APA - The Engineered Wood Association.
  - 3. Lumber: DOC PS 20.
  - 4. Wood Structural Panels: DOC PS 1 or DOC PS 2.
- B. Apply label from agency approved by authority having jurisdiction to identify each preservative-treated material.
- C. Maintain copy of each standard affecting the Work of this Section on-Site.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Lumber Grading Rules: WCLIB or WWPA G-5.
- B. Miscellaneous Framing: Hem-Fir or DF-Lspecies, No. 2 grade; 19 percent maximum moisture content.
- C. Plywood: APA-rated sheathing, Grade C-D; Exposure Durability 1; sanded.

### 2.02 FACTORY WOOD TREATMENT

- A. Wood Preservative (Pressure Treatment): AWPA U1, commodity specification A-sawn products or F-wood composites using waterborne preservative.
- B. Moisture Content after Treatment: Kiln dried (KDAT).
  - 1. Lumber: Maximum 19 percent.
  - 2. Structural Panels: Maximum 15 percent.

### 2.03 ACCESSORIES

- A. Fasteners and Anchors:
  - 1. Fasteners: ASTM A153, hot-dip galvanized or stainless steel for high-humidity and treated wood locations, unfinished steel elsewhere.
  - 2. Nails and Staples: ASTM F1667.
  - 3. Anchors: Expansion shield and lag bolt type for anchorage to solid masonry or concrete; bolt or ballistic fastener for anchorages to steel.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that substrate conditions are ready to receive blocking, curbing, and framing.

### **3.02 PREPARATION**

- A. Coordinate placement of blocking, curbing, and framing items.

### **3.03 INSTALLATION**

- A. Set members level and plumb, in correct position.
- B. Place horizontal members, crown side up.
- C. Secure sheathing to framing members with ends over firm bearing and staggered.
- D. Install telephone and electrical panel backboards with plywood sheathing material where required. Size backboards 12 inches beyond size of electrical and telephone panel.

### **3.04 SITE-APPLIED WOOD TREATMENT**

- A. Treat Site-sawn cuts. Apply preservative to Site-sawn cuts according to AWP A M4.
- B. Allow preservative to dry prior to erecting members.

### **3.05 ATTACHMENTS**

- A. Blocking: Spruce, pine, or fir species; 19 percent maximum moisture content; pressure-preservative treatment.
- B. Telephone and Electrical Panel Boards and Wood Decking: 3/4 inch thick, square edges, site-brush-applied preservative treated.

**END OF SECTION**

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**SECTION 06 41 16****PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Plastic-laminate-clad architectural cabinets.
2. Cabinet hardware and accessories.
3. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

**B. Related Requirements:**

1. Section 06 10 00 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.
2. Section 12 36 61.16 "Solid Surfacing Countertops."

**1.02 COORDINATION**

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

**1.03 ACTION SUBMITTALS****A. Product Data:** For each type of product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

**B. Shop Drawings:**

1. Include plans, elevations, sections, and attachment details.
2. Show large-scale details.
3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
5. Apply AWI Quality Certification Program label to Shop Drawings.

- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's or manufacturer's standard size.

- D. Samples for Initial Selection: For each type of exposed finish.

- E. Samples for Verification: For the following:
1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.
    - a. Provide one sample applied to core material with specified edge material applied to one edge.
  2. Thermally Fused Laminate (TFL) Panels: 8 by 10 inches, for each color, pattern, and surface finish.
    - a. Provide edge banding on one edge.
  3. Corner Pieces:
    - a. Cabinet-front frame joints between stiles and rails and at exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
    - b. Miter joints for standing trim.
  4. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For the following:
1. Composite wood products.
  2. Thermally fused laminate panels.
  3. High-pressure decorative laminate.
  4. Adhesives.
- C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
- D. Field quality-control reports.

#### 1.05 CLOSEOUT SUBMITTALS

- A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

#### 1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
1. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.
- B. Installer Qualifications: Licensed participant in AWI's Quality Certification Program.



#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

#### 1.08 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

### PART 2 - PRODUCTS

#### 2.01 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
  - 1. Provide certificates from AWI certification program indicating that woodwork and installation complies with requirements of grades specified.
  - 2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- B. Architectural Woodwork Standards Grade: Custom.
- C. Type of Construction: Frameless.
- D. Door and Drawer-Front Style: Flush overlay.
  - 1. Reveal Dimension: 1/2 inch.

- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
- F. Laminate Cladding for Exposed Surfaces:
  - 1. Horizontal Surfaces: Grade HGS.
  - 2. Postformed Surfaces: Grade HGP.
  - 3. Vertical Surfaces: Grade VGS.
  - 4. Edges: Grade HGS.
  - 5. Pattern Direction: Vertically for doors and fixed panels, horizontally for drawer fronts.
- G. Materials for Semiexposed Surfaces:
  - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.
    - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish.
    - b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.
  - 2. Drawer Sides and Backs: Thermally fused laminate panels with PVC or polyester edge banding.
  - 3. Drawer Bottoms: Thermally fused laminate panels.
- H. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
  - 1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners.
- I. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
  - 1. As selected by Architect from laminate manufacturer's full range in the following categories:
    - a. Solid colors, matte finish.
    - b. Solid colors with core same color as surface, matte finish.

## 2.02 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
  - 1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
  - 1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.

## 2.03 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 71 00 "Door Hardware."
- B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 135 degrees of opening, self-closing.
- C. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.
- D. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.
- E. Catches: Push-in magnetic catches, ANSI/BHMA A156.9, B03131.
- F. Adjustable Shelf Standards and Supports: ANSI/BHMA A156.9, B04071; with shelf rests, B04081.
- G. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.
- H. Drawer Slides: ANSI/BHMA A156.9.
  - 1. Standard Duty (Grade 1 and Grade 2): Side mount .
    - a. Type: Full overtravel extension.
    - b. Material: Galvanized steel ball bearing slides.
  - 2. General-purpose drawers more than 3 inches high, but not more than 6 inches high and not more than 24 inches wide, provide 75 lb load capacity.
- I. Door Locks: ANSI/BHMA A156.11, E07121.
- J. Drawer Locks: ANSI/BHMA A156.11, E07041.
- K. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- L. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.
  - 1. Satin Chromium Plated: ANSI/BHMA 626 for brass or bronze base; ANSI/BHMA 652 for steel base.
- M. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

## 2.04 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

## 2.05 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
  - 1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
  - 2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- C. Shop-cut openings to maximum extent possible to receive hardware, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

### 3.02 INSTALLATION

- A. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- B. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- C. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
  - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
  - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
  - 3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.

### 3.03 FIELD QUALITY CONTROL

- A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

- 1. Inspection entity shall prepare and submit report of inspection.

### 3.04 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces.

**END OF SECTION 06 41 16**

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**SECTION 06 80 00**  
**COMPOSITE FABRICATION**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section includes glass-fiber-reinforced-plastic stair tread covers.

**1.02 COORDINATION**

- A. Coordinate installation of anchorages for stair tread covers and supports. Furnish setting drawings, templates, and directions for installing anchorages. Deliver such items to Project site in time for installation.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For glass-fiber-reinforced-plastic stair tread covers.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work.

**1.04 FIELD CONDITIONS**

- A. Field Measurements: Verify actual locations of construction contiguous with stair tread covers by field measurements before fabrication.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Basis of Design – manufactured by Fibergrate Composite Structures subject to compliance with requirements listed. Product: Fiberplate Stair Tread Covers

**2.02 GLASS-FIBER-REINFORCED-PLASTIC STAIR TREAD COVERS**

- A. Molded Glass-Fiber-Reinforced Stair Tread Covers: Reinforced with a woven glass mat for durability and impact resistance.
  - 1. Stair tread covers come in 8-inch, 9-inch, 10-inch, 11-inch and 12-inch depths.
  - 2. Nominal thickness is 1/8 inch.
  - 3. Standard 12-foot panels, cut to size during installation, or are available precut to custom lengths.
  - 4. Integral aluminum oxide grit-top surface provides secure footing for maximum safety and a highly durable tread.

- B. Stair Tread Cover shall be of a one-piece molded construction manufactured by building up multiple layers of resin-impregnated, bi-directional fiberglass mat reinforcements which are continuous and equally oriented in the length and width directions. Percentage of glass (by weight) shall not exceed 35 percent so as to achieve maximum corrosion resistance, and as required to maintain the structural requirements indicated.
  - 1. No dry glass fibers shall be visible on any surface. All surfaces shall be smooth and uniform with no evidence of fiber orientation irregularities, interlaminar voids, resin rich or resin starved areas.
- C. Aluminum oxide grit surface shall be integrally molded into the cover.
- D. Fire rating: Stair Tread Cover shall be fire retardant with a tested flame spread rating of 25 or less when tested in accordance with ASTM E 84. Certifications shall be dated within the past two years and test data performed only on the resin shall not be acceptable.
- E. Resin system: The resin system used in the manufacture of the plate shall be Vi-Corr. Manufacturer may be required to submit corrosion data from tests performed on actual plate products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of plate product corrosion resistance and shall not be accepted.
- F. Color: Dark Gray. Nosing of the tread shall be readily discernable from the landing of the tread for compliance with OSHA standards.
- G. Depth: 1/8 inch with a tolerance of plus or minus 1/16 inch.
- H. Load/Deflection: Stair tread covers shall be fully supported over existing steel stair treads.

#### 2.03 FASTENERS AND HARDWARE

- A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners and hold-down clips for exterior use. Select fasteners for type, grade, and class required.

#### 2.04 FABRICATION

- A. Measurements: Stair tread covers supplied shall meet the dimensional requirements and tolerances as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to fit field conditions as required by manufacturer to complete the work. When field dimensions are not required, contractor shall determine correct size and locations of required holes or cutouts from field dimensions before plate fabrication. Contractor shall provide manufacturer with hold-down clip spacing or shall field locate. If field locating clip spacing for open grating treads, set tread in place and mark hole locations from the bottom to avoid bar interference. If field locating clip spacing for solid, existing concrete or wood treads, mark desired hole from the top, then turn tread over and drill from the bottom to minimize damage to twist drills by contact with the aluminum oxide
- B. Sealing: Shop fabricated plate cuts and holes shall be coated with vinyl ester resin to provide maximum corrosion resistance. Field fabricated plate cuts shall be coated similarly by the subcontractor in accordance with the manufacturer's instructions.



- C. Hardware: Provided and spaced at a maximum of three feet apart with a minimum of four per cover, or as recommended by the manufacturer. Fasteners should be low profile round or truss head bolts or screws

### **PART 3 - EXECUTION**

#### **3.01 INSPECTION**

- A. Shop inspection is authorized as required by the Owner and shall be at Owner's expense. The fabricator shall give ample notice to Contractor prior to the beginning of any fabrication work so that inspection may be provided. The cover shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits. The surface shall have a smooth finish (except for grit top surfaces).

#### **3.02 INSTALLING GLASS-FIBER-REINFORCED-PLASTIC TREADS**

- A. Install stair tread covers in accordance with manufacturer's assembly drawings. Lock tread covers securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation

**END OF SECTION**

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**SECTION 07 21 00**  
**THERMAL INSULATION**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
1. Glass-fiber blanket insulation.
  2. Mineral-wool blanket insulation.

**1.02 ACTION SUBMITTALS**

- A. Product Data: For the following:
1. Glass-fiber blanket insulation.
  2. Mineral-wool blanket insulation.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
1. For blown-in or sprayed fiberglass and cellulosic-fiber loose-fill insulation, indicate initial installed thickness, settled thickness, settled R-value, installed density, coverage area, and number of bags installed.
  2. Sign, date, and post the certification in a conspicuous location on Project site.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Research Reports: For foam-plastic insulation, from ICC-ES.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
  2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
  3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

## **PART 2 - PRODUCTS**

### **2.01 GLASS-FIBER BLANKET INSULATION**

- A. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.
  - 1. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
  - 2. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
  - 3. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

### **2.02 MINERAL-WOOL BLANKET INSULATION**

- A. Mineral-Wool Blanket Insulation, Unfaced: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.
  - 1. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
  - 2. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
  - 3. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

### **2.03 INSULATION FASTENERS**

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
  - 1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.
- B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
  - 1. Angle: Formed from 0.030-inch- thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
  - 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

### **2.04 ACCESSORIES**

- A. Insulation for Miscellaneous Voids:
  - 1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

### **3.02 INSTALLATION, GENERAL**

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Install insulation with manufacturer's R-value label exposed after insulation is installed.
- D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

### **3.03 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION**

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
  - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
  - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
  - 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
  - 4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
  - 5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
  - 1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..

3.04 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

**END OF SECTION**

## SECTION 07 42 13.19 - INSULATED METAL WALL PANELS

### PART 1 - GENERAL

#### 1.01 SUMMARY

##### A. Section Includes:

1. Foamed-insulation-core metal wall panels.

##### B. Related Requirements:

1. Section 07 62 00 "Sheet Metal Flashing and Trim" for sheet metal copings, and flashings,
2. Section 07 92 00 "Joint Sealants" for field-applied joint sealants.
3. Section 08 51 13 "Aluminum Windows" for aluminum windows integrated into the insulated metal panels system..
4. Section 08 91 19 "Fixed Louvers" for aluminum louvers integrated into the insulated metal panels system..
5. Section 10 73 13 "Awnings" for aluminum modular awnings integrated with the insulated metal panels system..

#### 1.02 PREINSTALLATION MEETINGS

##### A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.
8. Review procedures for repair of metal panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

#### 1.03 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

- B. Shop Drawings:
  - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
  - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
  - 1. Include similar Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below.
  - 1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

#### 1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

#### 1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
  - 1. Build mockup of typical metal panel assembly as shown on Drawings, including corner, supports, attachments, and accessories.
  - 2. Water-Spray Test: Conduct water-spray test of metal panel assembly mockup, testing for water penetration according to AAMA 501.2.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.



#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

#### 1.08 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

#### 1.09 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including rupturing, cracking, or puncturing.
    - b. Deterioration of metals and other materials beyond normal weathering.
  - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E72:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 6.24 lbf/sq. ft..
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 6.24 lbf/sq. ft..
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- E. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
  - 1. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E119.
  - 2. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies.
  - 3. Radiant Heat Exposure: No ignition when tested according to NFPA 268.
  - 4. Potential Heat: Acceptable level when tested according to NFPA 259.
  - 5. Surface-Burning Characteristics: Provide wall panels with a flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84.

### 2.02 SYSTEM DESCRIPTION

- A. Insulated Metal Wall Panel System: Halogen-Free, Factory-foamed-in-place horizontal and vertical wall panel system consisting of an exterior metal face sheet with interior metal liner panel, bonded to factory foamed-in-place core in thermally-separated profile, utilizing no glues or adhesives, with factory sealed tongue-and-groove and pressure-equalized rainscreen-designed horizontal side joint, attached to supports using concealed fasteners.

## 2.03 FOAMED-INSULATION-CORE METAL WALL PANELS

- A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
1. Insulation Core: Halogen- Free, Foamed-in-place isocyanurate foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
    - a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.
    - b. Density: 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622.
    - c. Compressive Strength: Minimum 20 psi when tested according to ASTM D1621.
    - d. Shear Strength: 26 psi when tested according to ASTM C273/C273M.
- B. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
1. Basis of Design: CENTRIA, Formawall Dimension Series Insulated Core Metal Wall Panels. Provide basis of design product.
    - a. CENTRIA Architectural Systems; Moon Township, PA 15108-2944. Tel: (800)759-7474. Tel: (412)299-8000. Fax: (412)299-8317. Email: [info@CENTRIA.com](mailto:info@CENTRIA.com). Web: [www.CENTRIA.com](http://www.CENTRIA.com)
  2. Metallic-Coated Steel Sheet: Facings of zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
    - a. Nominal Thickness: 0.028 inch.
    - b. Exterior Finish: Three-coat fluoropolymer. 0.8 mil primer with 0.8 mil 70 percent PVDF fluoropolymer color coat, and a 0.8 mil 70 percent PVDF fluoropolymer clear coat, AAMA 621
      - 1) Basis of Design: CENTRIA Duragard Plus.
      - 2) Color: As selected by Architect from manufacturer's full range.
    - c. Interior Finish: Siliconized polyester.
      - 1) Color: As selected by Architect from manufacturer's full range.
  3. Snap-on Batten: Same material, finish, and color as exterior facings of wall panels.
  4. Panel Coverage: 24 inches nominal.
  5. Panel Thickness: 3.0 inches.
  6. Thermal-Resistance Value (R-Value): 24.1 according to ASTM C1363.

## 2.04 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
  - 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
  - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
  - 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping stainless steel screws designed to withstand design loads.
- E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
  - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
  - 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
  - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

## 2.05 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
  - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
  - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
  - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

## 2.06 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
  1. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
- D. Aluminum Panels and Accessories:
  1. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
  1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

### 3.03 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
  - 1. Shim or otherwise plumb substrates receiving metal panels.
  - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
  - 3. Install screw fasteners in predrilled holes.
  - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
  - 5. Install flashing and trim as metal panel work proceeds.
  - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
  - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
  - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
  - 1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal wall panel manufacturer.
  - 1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
  - 2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."

### 3.04 INSULATED METAL WALL PANEL INSTALLATION

- A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.

1. Fasten foamed-insulation-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
  2. Apply panels and associated items true to line for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
  3. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
  4. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.
- B. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.
1. Install clips to supports with self-tapping fasteners.
- C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
  2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

### 3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration according to AAMA 501.2.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.
- D. Metal wall panels will be considered defective if they do not pass test and inspections.
- E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- F. Prepare test and inspection reports.

3.06 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

**END OF SECTION 07 42 13.19**



**SECTION 07 62 00****SHEET METAL FLASHING AND TRIM****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Formed roof-drainage sheet metal fabrications.
2. Formed low-slope roof sheet metal fabrications.
3. Formed wall sheet metal fabrications.
4. Formed equipment support flashing.

**B. Related Requirements:**

1. Section 06 10 00 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 07 42 13.19 "Insulated Metal Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
3. Section 07 72 00 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

**1.02 COORDINATION**

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

**1.03 PREINSTALLATION MEETINGS****A. Preinstallation Conference: Conduct conference at Project site.**

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

**1.04 ACTION SUBMITTALS****A. Product Data: For each of the following**

1. Underlayment materials.
2. Elastomeric sealant.
3. Butyl sealant.

4. Epoxy seam sealer.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Include details of special conditions.
11. Include details of connections to adjoining work.
12. Revise subparagraph below to suit Project. Delete if manufacturer's product data are adequate. Sheet metal flashing and trim fabricators do not custom form all accessory types.
13. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.

D. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Product Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved.
- C. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- D. Evaluation Reports: For copings and roof edge flashing, from ICC-ES showing compliance with ANSI/SPRI/FM 4435/ES-1.
- E. Sample Warranty: For special warranty.

#### 1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.
- B. Special warranty.

#### 1.07 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
  - 1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved, shop shall be listed as able to fabricate required details as tested and approved.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  - 1. Build mockup of typical roof edge, including fascia, approximately 10 feet long, including supporting construction cleats, seams, attachments, underlayment, and accessories.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.08 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
  - 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
  - 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

#### 1.09 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
  - 1. Design Pressure: As indicated on Drawings.
- D. FM Approvals Listing: Manufacture and install roof edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. Identify materials with name of fabricator and design approved by FM Approvals.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

### 2.02 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 coating designation; prepainted by coil-coating process to comply with ASTM A755/A755M.
  - 1. Surface: Smooth, flat.
  - 2. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 3. Color: As selected by Architect from manufacturer's full range.
  - 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

## 2.03 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. ATAS International, Inc.
    - b. Carlisle WIP Products; a brand of Carlisle Construction Materials.
    - c. Polyglass U.S.A., Inc.
  - 2. Source Limitations: Obtain underlayment from single source from single manufacturer.
  - 3. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F or lower.
- B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

## 2.04 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
    - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
  - 2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- D. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

## 2.05 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
  - 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
  - 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  - 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
  - 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
  - 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
  - 1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
  - 2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
  - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
  - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.
- G. Seams:
  - 1. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.
- H. Do not use graphite pencils to mark metal surfaces.

## 2.06 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters:
  - 1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
  - 2. Fabricate in minimum 96-inch- long sections.

3. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
  4. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
  5. Gutter Profile: Style A in accordance with cited sheet metal standard.
  6. Expansion Joints: Butt type with cover plate.
  7. Accessories: Wire-ball downspout strainer.
  8. Gutters with Girth up to 25 Inches: Fabricate from the following materials:
    - a. Galvanized Steel: 0.034 inch thick.
  9. Gutters with Girth 26 to 30 Inches: Fabricate from the following materials:
    - a. Galvanized Steel: 0.040 inch thick.
  10. Gutters with Girth 31 to 35 Inches: Fabricate from the following materials:
    - a. Galvanized Steel: 0.052 inch thick.
- B. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
1. Fabricated Hanger Style: Fig. 1-35H in accordance with SMACNA's "Architectural Sheet Metal Manual."
  2. Fabricate from the following materials:
    - a. Galvanized Steel: 0.052 inch thick.

## 2.07 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing and Fascia Cap: Fabricate in minimum 96-inch- long, but not exceeding 12-foot-long sections. Furnish with 6-inch- wide, joint cover plates. Shop fabricate interior and exterior corners.
1. Joint Style: Butted with expansion space and 6-inch- wide, concealed backup plate.
  2. Fabricate from the following materials:
    - a. Galvanized Steel: 0.028 inch thick.
- B. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch thick.
- C. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Galvanized Steel: 0.022 inch thick.
- D. Flashing Receivers: Fabricate from the following materials:
1. Galvanized Steel: 0.022 inch thick.
- E. Roof-Penetration Flashing: Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch thick.

## 2.08 WALL SHEET METAL FABRICATIONS

- A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:
  - 1. Galvanized Steel: 0.022 inch thick.

## 2.09 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following materials:
  - 1. Galvanized Steel: 0.028 inch thick.
- B. Overhead-Piping Safety Pans: Fabricate from the following materials:
  - 1. Galvanized Steel: 0.040 inch thick.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
  - 1. Verify compliance with requirements for installation tolerances of substrates.
  - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
  - 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering, High-Temperature Sheet Underlayment:
  - 1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
  - 2. Prime substrate if recommended by underlayment manufacturer.
  - 3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
  - 4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
  - 5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
  - 6. Roll laps and edges with roller.
  - 7. Cover underlayment within 14 days.
- B. Install slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.
  - 1. Install in shingle fashion to shed water.
  - 2. Lapp joints not less than 4 inches.



### 3.03 INSTALLATION, GENERAL

- A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
  - 1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  - 2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
  - 3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
  - 4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
  - 5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
  - 6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
  - 7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
  - 8. Do not field cut sheet metal flashing and trim by torch.
  - 9. Do not use graphite pencils to mark metal surfaces.
- B. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
  - 1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
  - 2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
  - 3. Use lapped expansion joints only where indicated on Drawings.
- C. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- E. Seal joints as required for watertight construction.
  - 1. Use sealant-filled joints unless otherwise indicated.
    - a. Embed hooked flanges of joint members not less than 1 inch into sealant.
    - b. Form joints to completely conceal sealant.
    - c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
    - d. Adjust setting proportionately for installation at higher ambient temperatures.
      - 1) Do not install sealant-type joints at temperatures below 40 deg F.
  - 2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."

### 3.04 INSTALLATION OF ROOF-DRAINAGE SYSTEM

- A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters:
  - 1. Join sections with joints sealed with sealant.
  - 2. Provide for thermal expansion.
  - 3. Attach gutters at eave or fascia to firmly anchor them in position.
  - 4. Provide end closures and seal watertight with sealant.
  - 5. Slope to downspouts.
  - 6. Fasten gutter spacers to front and back of gutter.
  - 7. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches apart.
  - 8. Anchor gutter with gutter brackets spaced not more than 24 inches apart to roof deck unless otherwise indicated, and loosely lock to front gutter bead.
  - 9. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 feet apart. Install expansion-joint caps.
- C. Downspouts:
  - 1. Join sections with 1-1/2-inch telescoping joints.
  - 2. Provide hangers with fasteners designed to hold downspouts securely to walls.
  - 3. Locate hangers at top and bottom and at approximately 60 inches o.c.
  - 4. Connect downspouts to underground drainage system.

### 3.05 INSTALLATION OF ROOF FLASHINGS

- A. Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard.
  - 1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
  - 2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing:
  - 1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
  - 2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
  - 3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.
- C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.
- D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
  - 1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
  - 2. Extend counterflashing 4 inches over base flashing.

3. Lap counterflashing joints minimum of 4 inches.
4. Secure in waterproof manner by means of anchor and washer spaced at 12 inches o.c. along perimeter and 6 inches o.c. at corners areas unless otherwise indicated.

- E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

### 3.06 INSTALLATION OF WALL FLASHINGS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

### 3.07 INSTALLATION OF MISCELLANEOUS FLASHING

- A. Equipment Support Flashing:
1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
  2. Weld or seal flashing with elastomeric sealant to equipment support member.
- B. Overhead-Piping Safety Pans:
1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
  2. Pipe and install drain line to plumbing waste or drainage system.

### 3.08 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### 3.09 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

### 3.10 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

**END OF SECTION 07 62 00**

**SECTION 07 72 00**  
**ROOF ACCESSORIES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Roof hatches.

**B. Related Requirements:**

1. Section 05 50 00 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 07 62 00 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, and miscellaneous sheet metal trim and accessories.

**1.02 COORDINATION**

- A.** Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B.** Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

**1.03 ACTION SUBMITTALS**

**A. Product Data:** For each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

**B. Shop Drawings:** For roof accessories.

1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

**C. Delegated-Design Submittal:** For roof curbs and equipment supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
  - 1. Size and location of roof accessories specified in this Section.
  - 2. Method of attaching roof accessories to roof or building structure.
  - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
  - 4. Required clearances.
- B. Sample Warranties: For manufacturer's special warranties.

#### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

#### 1.06 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, licensed in the State of New Mexico, to design roof curbs and equipment supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Wind-Restraint Performance: As indicated on Drawings.

## 2.02 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.
- B. Aluminum Sheet: ASTM B209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
  - 1. Mill Finish: As manufactured.
- C. Aluminum Extrusions and Tubes: ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.
- D. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.
- E. Steel Tube: ASTM A500/A500M, round tube.
- F. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.
- G. Steel Pipe: ASTM A53/A53M, galvanized.

## 2.03 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F, thickness as indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Underlayment:
  - 1. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
- F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
  - 1. Fasteners for Zinc-Coated: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
  - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- H. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- I. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

#### 2.04 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION

- A. Install roof accessories according to manufacturer's written instructions.
  - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
  - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
  - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
  - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
  - 1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.



2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Roof-Hatch Installation:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post according to manufacturer's written instructions.

D. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.03 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 91 13 "Exterior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

**END OF SECTION 07 72 00**

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**SECTION 07 92 00****JOINT SEALANTS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
1. Silicone joint sealants.
  2. Nonstaining silicone joint sealants.
  3. Urethane joint sealants.
  4. Mildew-resistant joint sealants.
  5. Butyl joint sealants.
  6. Latex joint sealants.

**1.02 ACTION SUBMITTALS**

- A. Product Data:
1. Joint-sealants.
  2. Joint sealant backing materials.
- B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
1. Joint-sealant application, joint location, and designation.
  2. Joint-sealant manufacturer and product name.
  3. Joint-sealant formulation.
  4. Joint-sealant color.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Test and Evaluation Reports:
1. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
    - a. Joint-sealant location and designation.
    - b. Manufacturer and product name.
    - c. Type of substrate material.
    - d. Proposed test.

- e. Number of samples required.
  - 2. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- B. Field Quality-Control Submittals:
- 1. Field-Adhesion-Test Reports: For each sealant application tested.
- C. Sample warranties.
- 1.04 CLOSEOUT SUBMITTALS
- A. Warranty Documentation:
- 1. Manufacturers' special warranties.
  - 2. Installer's special warranties.
- 1.05 QUALITY ASSURANCE
- A. Qualifications:
- 1. Installers: Authorized representative who is trained and approved by manufacturer.
  - 2. Testing Agency: Qualified in accordance with ASTM C1021 to conduct the testing indicated.
- 1.06 MOCKUPS
- A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.
- 1.07 PRECONSTRUCTION TESTING
- A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
- 1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
  - 2. Conduct field tests for each kind of sealant and joint substrate.
  - 3. Notify Architect seven days in advance of dates and times when test joints will be erected.
  - 4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
- a. Test Method: Test joint sealants in accordance with Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
    - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

#### 1.08 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
  1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
  2. When joint substrates are wet.
  3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

#### 1.09 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
  1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
  2. Disintegration of joint substrates from causes exceeding design specifications.
  3. Mechanical damage caused by individuals, tools, or other outside agents.
  4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

### PART 2 - PRODUCTS

#### 2.01 SOURCE LIMITATIONS

- A. Obtain joint sealants from single manufacturer for each sealant type.

## 2.02 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

## 2.03 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.
- B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

## 2.04 URETHANE JOINT SEALANTS

- A. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.
- B. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.

## 2.05 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

## 2.06 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.

## 2.07 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

## 2.08 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) Type O (open-cell material) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

## 2.09 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    - a. Concrete.
    - b. Masonry.

- c. Unglazed surfaces of ceramic tile.
  - d. Exterior insulation and finish systems.
  - e. Remove laitance and form-release agents from concrete.
- 3. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
  - a. Metal.
  - b. Glass.
  - c. Porcelain enamel.
  - d. Glazed surfaces of ceramic tile.
  - e. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- B. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.03 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth,



uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile at locations indicated on Drawings in accordance with Figure 8B in ASTM C1193.
5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings in accordance with Figure 8C in ASTM C1193.
  - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

### 3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
    - a. Extent of Testing: Test completed and cured sealant joints as follows:
      - 1) Perform 10 tests for the first 1000 ft. of joint length for each kind of sealant and joint substrate.
      - 2) Perform one test for each 1000 ft. of joint length thereafter or one test per each floor per elevation.
    - b. Test Method: Test joint sealants in accordance with Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
      - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
    - c. Inspect tested joints and report on the following:
      - 1) Whether sealants filled joint cavities and are free of voids.
      - 2) Whether sealant dimensions and configurations comply with specified requirements.
      - 3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
    - d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

- e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
    - 2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
  - C. Prepare test and inspection reports.
- 3.05 CLEANING
- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
- 3.06 PROTECTION
- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.
- 3.07 JOINT-SEALANT SCHEDULE
- A. Exterior joints in horizontal traffic surfaces :
    - 1. Joint Locations:
      - a. Control and expansion joints in brick pavers.
      - b. Isolation and contraction joints in cast-in-place concrete slabs.
      - c. Joints between plant-precast architectural concrete paving units.
      - d. Joints in stone paving units, including steps.
      - e. Tile control and expansion joints.
      - f. Joints between different materials listed above.
      - g. Other joints as indicated on Drawings.
    - 2. Joint Sealant: Urethane, M, P, 50, T, NT.
    - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
  - B. Exterior joints in vertical surfaces and horizontal nontraffic surfaces :
    - 1. Joint Locations:
      - a. Construction joints in cast-in-place concrete.
      - b. Joints between plant-precast architectural concrete units.
      - c. Control and expansion joints in unit masonry.
      - d. Joints in dimension stone cladding.
      - e. Joints in glass unit masonry assemblies.

- f. Joints in exterior insulation and finish systems.
    - g. Joints between metal panels.
    - h. Joints between different materials listed above.
    - i. Perimeter joints between materials listed above and frames of doors windows and louvers.
    - j. Control and expansion joints in ceilings and other overhead surfaces.
    - k. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Interior joints in horizontal traffic surfaces :
- 1. Joint Locations:
    - a. Isolation joints in cast-in-place concrete slabs.
    - b. Control and expansion joints in stone flooring.
    - c. Control and expansion joints in brick flooring.
    - d. Control and expansion joints in tile flooring.
    - e. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Urethane, S, P, 25, T, NT.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement :
- 1. Joint Locations:
    - a. Control joints on exposed interior surfaces of exterior walls.
    - b. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
    - c. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Acrylic latex.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces :
- 1. Joint Locations:
    - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    - b. Tile control and expansion joints where indicated.
    - c. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Concealed mastics :
- 1. Joint Locations:
    - a. Aluminum thresholds.
    - b. Sill plates.
    - c. Other joints as indicated on Drawings.

2. Joint Sealant: Butyl-rubber based.

**END OF SECTION 07 92 00**

**SECTION 08 11 13****HOLLOW METAL DOORS AND FRAMES****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes:
  - 1. Interior standard steel doors and frames.
  - 2. Exterior standard steel doors and frames.
- B. Related Requirements:
  - 1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.

**1.02 DEFINITIONS**

- A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

**1.03 COORDINATION**

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

**1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.
- B. Shop Drawings: Include the following:
  - 1. Elevations of each door type.
  - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
  - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  - 4. Locations of reinforcement and preparations for hardware.
  - 5. Details of each different wall opening condition.
  - 6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
  - 7. Details of anchorages, joints, field splices, and connections.

8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

C. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.
2. Fabrication: Prepare Samples approximately 8 by 10 inches to demonstrate compliance with requirements for quality of materials and construction:
  - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
  - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

D. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

#### 1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.

C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

D. Field quality control reports.

#### 1.06 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

#### 1.07 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

- B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
  - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDI) certification.

#### 1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
  - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
  - 1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
  - 2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
- B. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.50 deg Btu/F x h x sq. ft. when tested in accordance with ASTM C1363 or ASTM E1423.

#### 2.02 INTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B..
  - 1. Doors:
    - a. Type: As indicated in the Door and Frame Schedule.
    - b. Thickness: 1-3/4 inches.

- c. Face: Uncoated steel sheet, minimum thickness of 0.042 inch.
- d. Edge Construction: Model 1, Full Flush.
- e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
- f. Core: Manufacturer's standard.
- g. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.

2. Frames:

- a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
- b. Construction: Face welded.

3. Exposed Finish: Prime.

## 2.03 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

- B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A..

1. Doors:

- a. Type: As indicated in the Door and Frame Schedule.
- b. Thickness: 1-3/4 inches.
- c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
- d. Edge Construction: Model 2, Seamless.
- e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
- f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
- g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
- h. Core: Manufacturer's standard.
- i. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.

2. Frames:

- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
- b. Construction: Full profile welded.

3. Exposed Finish: Prime.

## 2.04 FRAME ANCHORS

- A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.



2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
  3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

## 2.05 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

## 2.06 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
1. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
  2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
  3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

- a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
  - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
  - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
  - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

## 2.07 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
  - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

## 2.08 LOUVERS

- A. Provide louvers for interior doors, where indicated, which comply with SDI 111, with blades or baffles formed of 0.020-inch- thick, cold-rolled steel sheet set into 0.032-inch- thick steel frame.
  - 1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
- B. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

### 3.02 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
    - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    - b. Install frames with removable stops located on secure side of opening.
  2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
  3. Floor Anchors: Secure with postinstalled expansion anchors.
    - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
  4. Solidly pack mineral-fiber insulation inside frames.
  5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
  6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
  7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
    - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
  2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
  3. Smoke-Control Doors: Install doors in accordance with NFPA 105.

### 3.03 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
  2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

#### 3.04 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

**END OF SECTION 08 11 13**

**SECTION 08 31 13****ACCESS DOORS AND FRAMES****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Access doors and frames.

**B. Related Requirements:**

1. Section 23 33 00 "Air Duct Accessories" for heating and air-conditioning duct access doors.

**1.02 ACTION SUBMITTALS****A. Product Data:** For each type of product.

1. Include construction details material descriptions, dimensions of individual components and profiles, and finishes.

**B. Samples:** For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches in size.**C. Product Schedule:** For access doors and frames. Use same designations indicated on Drawings.**PART 2 - PRODUCTS****2.01 ACCESS DOORS AND FRAMES****A. Flush Access Doors with Exposed Flanges:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Bilco
  - b. Babcock-Davis.
  - c. nystrom.
  - d. Milcor.
2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
3. Locations: Wall and ceiling as indicated.
4. Door Size: as indicated.
5. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch, 16 gage, factory primed.
6. Stainless Steel Sheet for Door at Plastic Panel Walls: Nominal 0.062 inch, 16 gage, ASTM A480/A480M No. 4 finish.

7. Frame Material: Same material, thickness, and finish as door.
8. Latch and Lock: Cam latch, screwdriver operated.

## 2.02 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
- D. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, Type 316. Remove tool and die marks and stretch lines, or blend into finish.
- E. Stainless Steel Flat Bars: ASTM A666, Type 304. Remove tool and die marks and stretch lines, or blend into finish.
- F. Frame Anchors: Same material as door face.
- G. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

## 2.03 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
  1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
- D. Latch and Lock Hardware:
  1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
  2. Keys: Furnish two keys per lock and key all locks alike.

## 2.04 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
  - 2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil for topcoat.
    - a. Color: As selected by Architect from full range of industry colors.
- E. Stainless Steel Finishes:
  - 1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
  - 2. Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
    - a. Run grain of directional finishes with long dimension of each piece.
    - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 INSTALLATION**

- A. Comply with manufacturer's written instructions for installing access doors and frames.

#### **3.03 ADJUSTING**

- A. Adjust doors and hardware, after installation, for proper operation.

**END OF SECTION 08 31 13**

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**SECTION 08 51 13****ALUMINUM WINDOWS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes aluminum windows for exterior locations.

**1.02 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
  - 3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
  - 4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
  - 5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
- B. Shop Drawings: For aluminum windows.
  - 1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.
- C. Samples: For each exposed product and for each color specified, 2 by 4 inches in size.
- D. Samples for Verification: For aluminum windows and components required, showing full range of color variations for finishes, and prepared on Samples of size indicated below:
  - 1. Exposed Finishes: 2 by 4 inches.
- E. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For manufacturer's warranties.

#### 1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
- B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.
- C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Build mockup of typical wall area as shown on Drawings.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.06 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure to meet performance requirements.
    - b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
    - c. Faulty operation of movable sash and hardware.
    - d. Deterioration of materials and finishes beyond normal weathering.
    - e. Failure of insulating glass.
  - 2. Warranty Period:
    - a. Window: 10 years from date of Substantial Completion.
    - b. Glazing Units: 10 years from date of Substantial Completion.
    - c. Aluminum Finish: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

### 2.02 WINDOW PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
  - 1. Window Certification: AAMA certified with label attached to each window.
- B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
  - 1. Minimum Performance Class: AW.
  - 2. Minimum Performance Grade: 50.
- C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.30 Btu/sq. ft. x h x deg F.
- D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.27.
- E. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 52.
- F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.
- G. Sound Transmission Class (STC): Rated for not less than 30 STC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413.
- H. Outside-Inside Transmission Class (OITC): Rated for not less than 30 OITC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.
- I. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 3 for enhanced protection.

### 2.03 ALUMINUM WINDOWS

- A. Manufacturers: Basis-of Design subject to compliance with requirements, available manufacturer offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Centria, Formavue Windows FV-600
  - 2. Window must interface with insulated metal panel system

- B. Types: Provide the following types in locations indicated on Drawings:
1. Fixed.
- C. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.
1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.
- D. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.
1. Kind: Fully tempered where indicated on Drawings.
- E. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C1172 with two plies of float glass.
1. Float Glass: Fully tempered.
  2. Inner Ply: Clear.
  3. Interlayer: As required by performance requirements indicated.
  4. Outer Ply: Clear.
  5. Low-E Coating: Pyrolytic on second surface.
- F. Insulating-Glass Units: ASTM E2190.
1. Glass: ASTM C1036, Type 1, Class 1, q3.
    - a. Tint: Clear.
    - b. Kind: Fully tempered where indicated on Drawings.
  2. Lites: Two.
  3. Filling: Fill space between glass lites with argon.
  4. Low-E Coating: Pyrolytic on second surface.
- G. Windborne-Debris-Impact-Resistant Insulating-Glass Units: ASTM E2190 with two lites and complying with impact-resistance requirements in "Window Performance Requirements" Article.
1. Exterior Lite: ASTM C1036, Type 1, Class 1, q3.
    - a. Tint: Clear.
    - b. Kind: Fully tempered.
  2. Interior Lite: ASTM C1172 clear laminated glass with two plies of float glass.
    - a. Float Glass: Fully tempered.
    - b. Interlayer Thickness: As required by performance requirements indicated.
  3. Filling: Fill space between glass lites with argon.
  4. Low-E Coating: Pyrolytic on second surface.
- H. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.
1. Dual Glazing System:
    - a. Interior Lite: Glass.

b. Exterior Lite: Glass.

- I. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
- J. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.
  - 1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.04 FABRICATION

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
- B. Glaze aluminum windows in the factory.
- C. Weather strip each operable sash to provide weathertight installation.
- D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.05 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.06 ALUMINUM FINISHES

- A. High-Performance Organic Finish (Three-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coatings; Organic Coating: manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.
  - 1. Color and Gloss: As selected by Architect from full range of industry colors and color densities.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
- C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

### **3.03 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  - 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. Testing Services: Testing and inspecting of installed windows shall take place as follows:
  - 1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.
  - 2. Air-Infiltration Testing:
    - a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
    - b. Allowable Air-Leakage Rate: 1.5 times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.
  - 3. Water-Resistance Testing:

- a. Test Pressure: Two-thirds times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
  - b. Allowable Water Infiltration: No water penetration.
- 4. Testing Extent: Three windows of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows shall be tested after perimeter sealants have cured.
- 5. Test Reports: Prepared according to AAMA 502.
- C. Windows will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

#### 3.04 CLEANING, AND PROTECTION

- A. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
  - 1. Keep protective films and coverings in place until final cleaning.
- B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- C. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

**END OF SECTION 08 51 13**

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**SECTION 08 71 00****DOOR HARDWARE****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Mechanical door hardware for the following:
  - a. Swinging doors.
2. Cylinders for door hardware specified in other Sections.
3. Electrified door hardware.

**B. Related Requirements:**

1. Section 08 11 13 "Hollow Metal Doors and Frames" for door silencers provided as part of hollow-metal frames.

**1.02 COORDINATION**

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- D. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

**1.03 PREINSTALLATION MEETINGS****A. Preinstallation Conference: Conduct conference at Project site.**

1. Conference participants shall include Installer's Architectural Hardware Consultant.

**B. Keying Conference: Conduct conference at Project site.**

1. Conference participants shall include Installer's Architectural Hardware Consultant.

2. Incorporate conference decisions into keying schedule after reviewing door hardware keying system including, but not limited to, the following:
  - a. Flow of traffic and degree of security required.
  - b. Preliminary key system schematic diagram.
  - c. Requirements for key control system.
  - d. Requirements for access control.
  - e. Address for delivery of keys.

#### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For electrified door hardware.
  1. Include diagrams for power, signal, and control wiring.
  2. Include details of interface of electrified door hardware and building safety and security systems.
- C. Samples: For each exposed product in each finish specified, in manufacturer's standard size.
  1. Tag Samples with full product description to coordinate Samples with door hardware schedule.
- D. Samples for Verification: For each type of exposed product, in each finish specified.
  1. Sample Size: Full-size units or minimum 2-by-4-inch Samples for sheet and 4-inch long Samples for other products.
    - a. Full-size Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.
  2. Tag Samples with full product description to coordinate Samples with door hardware schedule.
- E. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
  1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
  2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
  3. Content: Include the following information:
    - a. Identification number, location, hand, fire rating, size, and material of each door and frame.

- b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
  - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
  - d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
  - e. Fastenings and other installation information.
  - f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
  - g. Mounting locations for door hardware.
  - h. List of related door devices specified in other Sections for each door and frame.
- F. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and Architectural Hardware Consultant.
- B. Product Certificates: For each type of electrified door hardware.
  - 1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.
- C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

#### 1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware schedule.

#### 1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
  - 1. Warehousing Facilities: In Project's vicinity.
  - 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
  - 3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

- B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

#### 1.08 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- D. Deliver keys to Owner by registered mail or overnight package service.

#### 1.09 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including excessive deflection, cracking, or breakage.
    - b. Faulty operation of doors and door hardware.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
  - 2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
    - a. Electromagnetic Locks: Five years from date of Substantial Completion.
    - b. Exit Devices: Two years from date of Substantial Completion.
    - c. Manual Closers: 10 years from date of Substantial Completion.
    - d. Concealed Floor Closers: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Source Limitations: Obtain each type of door hardware from single manufacturer.
  - 1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

## 2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
- B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested in accordance with UL 1784 and installed in compliance with NFPA 105.
  - 1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.
- C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the USDOT's "2010 ADA Standards for Accessible Design".
  - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
  - 2. Comply with the following maximum opening-force requirements:
    - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
    - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
  - 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
  - 4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
  - 5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

## 2.03 HINGES

- A. Hinges: BHMA A156.1.

## 2.04 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.
- B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
  - 1. Bored Locks: Minimum 1/2-inch latchbolt throw.
  - 2. Mortise Locks: Minimum 3/4-inch latchbolt throw.
  - 3. Deadbolts: Minimum 1-inch bolt throw.
- C. Lock Backset: 2-3/4 inches unless otherwise indicated.

D. Lock Trim:

1. Description: As indicated on Drawings.
2. Levers: Forged.
3. Escutcheons (Roses): Forged.
4. Dummy Trim: Match lever lock trim and escutcheons.

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

F. Mortise Locks: BHMA A156.13; Security Grade 1; stamped steel case with steel or brass parts; Series 1000.

2.05 ELECTRIC STRIKES

A. Electric Strikes: BHMA A156.31; Grade 1; with faceplate to suit lock and frame.

2.06 ELECTROMAGNETIC LOCKS

A. Electromagnetic Locks: BHMA A156.23; electrically powered; with electromagnet attached to frame and armature plate attached to door; full-exterior or full-interior type, as required by application indicated.

B. Delayed-Egress Electromagnetic Locks: BHMA A156.24, electrically powered, with electromagnet attached to frame and armature plate attached to door; depressing push bar for more than three seconds initiates irreversible alarm and adjustable time delay for egress. When integrated with fire alarm, fire alarm voids time delay.

2.07 ELECTROMECHANICAL LOCKS

A. Electromechanical Locks: BHMA A156.25; Grade 1; motor or solenoid driven; with strike that suits frame.

1. Type: Mortise deadbolt.

2.08 SELF-CONTAINED ELECTRONIC LOCKS

A. Self-Contained Electronic Locks: BHMA A156.25, mortise; with internal, battery-powered, self-contained electronic locks; consisting of complete lockset, motor-driven lock mechanism, and actuating device; enclosed in zinc-dichromate-plated, wrought-steel case, and strike that suits frame. Provide key override, low-battery detection and warning, LED status indicators, and ability to program at the lock.

2.09 EXIT LOCKS AND EXIT ALARMS

A. Exit Locks and Alarms: BHMA A156.29, Grade 1.

## 2.10 AUTOMATIC FLUSH BOLTS

- A. Automatic Flush Bolts: BHMA A156.3, Type 25; minimum 3/4-inch throw; with dust-proof strikes; designed for mortising into door edge.

## 2.11 EXIT DEVICES AND AUXILIARY ITEMS

- A. Exit Devices and Auxiliary Items: BHMA A156.3.

## 2.12 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
- B. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
- C. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

## 2.13 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.
  - 1. No Master Key System: Only change keys operate cylinders.
    - a. Provide three cylinder change keys.
  - 2. Master Key System: Change keys and a master key operate cylinders.
    - a. Provide three cylinder change keys and five master keys.
  - 3. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.
    - a. Provide three cylinder change keys and five each of master and grand master keys.
  - 4. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.
    - a. Provide three cylinder change keys and five each of master, grand master, and great-grand master keys.
  - 5. Existing System:
    - a. Master key or grand master key locks to Owner's existing system.
    - b. Re-key Owner's existing master key system into new keying system.
  - 6. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Brass.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
  - a. Notation: Information to be furnished by Owner.

#### 2.14 KEY CONTROL SYSTEM

- A. Key Control Cabinet: BHMA A156.28; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.
  1. Wall-Mounted Cabinet: Grade 1 cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.
- B. Key Lock Boxes: Designed for storage of two keys.
- C. Key Control System Software: Multiple-index system for recording and reporting key-holder listings, tracking keys and lock and key history, and printing receipts for transactions. Include instruction manual.

#### 2.15 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; stainless steel unless otherwise indicated.

#### 2.16 ACCESSORIES FOR PAIRS OF DOORS

- A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release.
- B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
- C. Astragals: BHMA A156.22.

#### 2.17 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

#### 2.18 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16.



## 2.19 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
- B. Maximum Air Leakage: When tested in accordance with ASTM E283 with tested pressure differential of 0.3-inch wg, as follows:
  - 1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. of door opening.
  - 2. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
  - 3. Gasketing on Double Doors: 0.50 cfm per ft. of door opening.

## 2.20 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

## 2.21 AUXILIARY DOOR HARDWARE

- A. Auxiliary Hardware: BHMA A156.16.

## 2.22 AUXILIARY ELECTRIFIED DOOR HARDWARE

## 2.23 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.
  - 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
  - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
  - 2. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

## 2.24 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Steel Doors Frames: For surface-applied door hardware, drill and tap frames in accordance with ANSI/SDI A250.6.
- B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

### 3.03 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
  - 1. Standard Steel Doors Frames: ANSI/SDI A250.8.
  - 2. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
  - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
  - C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
  - D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches of door height greater than 90 inches.
  - E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
    1. Replace construction cores with permanent cores as directed by Owner.
    2. Furnish permanent cores to Owner for installation.
  - F. Key Control System:
    1. Key Control Cabinet: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
    2. Key Lock Boxes: Install where indicated or approved by Architect to provide controlled access for fire and medical emergency personnel.
    3. Key Control System Software: Set up multiple-index system based on final keying schedule.
  - G. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.
    1. Configuration: Provide one power supply for each door opening with electrified door hardware.
  - H. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07 92 00 "Joint Sealants."
  - I. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
  - J. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
    1. Do not notch perimeter gasketing to install other surface-applied hardware.
  - K. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
  - L. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.
- 3.04 FIELD QUALITY CONTROL
- A. Independent Architectural Hardware Consultant: Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
    1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

### 3.05 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
  - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
  - 2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
- B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

### 3.06 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

### 3.07 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

### 3.08 DEMONSTRATION

- A. Engage Installer to train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

### 3.09 DOOR HARDWARE SCHEDULE

- A. Hardware Set 1: Each door to have the following:
  - 1. TBD.

**END OF SECTION 08 71 00**

**SECTION 08 91 19****FIXED LOUVERS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Fixed thin line louvers.
- B. Related Requirements:
  - 1. Section 07 92 00 "Joint Sealants" for sealants installed in perimeter joints between louver frames and adjoining construction.

**1.02 DEFINITIONS**

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).
- C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- D. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing in accordance with AMCA 500-L.
- E. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing in accordance with AMCA 540.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Air flow and water entrainment performance test results.
  - 2. Material types and thickness.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
  - 1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
  - 2. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed in accordance with AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.
- B. Windborne-debris-impact-resistance test reports.
- C. Sample Warranties: For manufacturer's special warranties.

#### 1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
  - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
  - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

#### 1.06 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Delivery: At the time of delivery all materials shall be visually inspected for damage. Any damaged boxes, crates, louver sections, etc. shall be noted on the receiving ticket and immediately reported to the shipping company and the material manufacturer.
- B. Storage:
  - 1. Material may be stored flat end or on its side.
  - 2. Material may be stored either indoors or outdoors.  
If stored outdoors the material must be raised sufficiently off the ground to prevent it being flooded.
  - 3. If stored outdoors the material must be covered with a weatherproof flame-resistant sheeting or tarpaulin.
- C. Handling:
  - 1. Material shall be handled in accordance with sound material handling practices and in such a way as to minimize racking.
  - 2. Louver sections may be hoisted by attaching straps to the jambs and lifting the section while it is in a vertical position.  
Louver sections should only be lifted and carried by the jambs. Heads, sills, and blades are not to be used for lifting or hoisting louver sections.

## 1.08 WARRANTY

- A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    - c. Cracking, peeling, or chipping.
  2. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Basis of Design – manufactured by Construction Specialties subject to compliance with requirements listed. The louvers and related materials herein specified and indicated on the drawings shall be manufactured by: Construction Specialties, 3 Werner Way, Lebanon, NJ 08833. Tel: 800.233.8493. Email: [cet@c-sgroup.com](mailto:cet@c-sgroup.com).
1. Model MW-9615: 9-inch Deep Storm Resistant Fixed Horizontal Integrated Louver
- B. Drawings and specifications are based on manufacturer's literature from Construction Specialties, Inc. drawings and specifications unless otherwise indicated. Other manufacturers must be approved equal by Architect/Owner

### 2.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.
1. Wind Loads:

- a. Determine loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward.
  - B. Seismic Performance:
    - 1. As indicated on Drawings.
  - C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.
  - D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
    - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
  - E. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
- 2.03 FIXED EXTRUDED-ALUMINUM LOUVERS
- A. Horizontal, Wind-Driven-Rain-Resistant Louver, Extruded Aluminum:
    - 1. Construction Specialties 9-inch Deep Storm Resistant Fixed Horizontal Integrated Louver Model MW-9615
    - 2. Louver Depth: 9 inches.
    - 3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
    - 4. Inactive louver shall be integrated with CENTRIA MetalWrap Series MR-300 Insulated Backup Panels. Where indicated on drawings CS louver model MW-9615 front blade shall be integrated with exterior of MetalWrap panel with custom mounting channel and braces. Louver and metal panel system integration must be an engineered system. Louver installation will not compromise metal panel system performance
    - 5. Louver Performance Ratings:
      - a. Air Performance: Not more than 0.25-inch wg static pressure drop at 900-fpm free-area intake velocity.
      - b. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 300 fpm.
    - 6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
- 2.04 LOUVER SCREENS
- A. General: Provide screen at each exterior louver.
    - 1. Screen Location for Fixed Louvers: Interior face.
    - 2. Screening Type: Bird screening.
  - B. Secure screen frames to louver frames with stainless steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.
  - C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.



1. Metal: Same type and form of metal as indicated for louver to which screens are attached.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type: Non-rewirable, U-shaped frames.

D. Louver Screening for Aluminum Louvers:

1. Bird Screening, Aluminum: 5/8-inch- square mesh, 0.050-inch wire.

## 2.05 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
  1. Use tamper-resistant screws for exposed fasteners unless otherwise indicated.
  2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
  3. For fastening galvanized steel, use hot-dip-galvanized-steel or 300 series stainless steel fasteners.
  4. For fastening stainless steel, use 300 series stainless steel fasteners.
  5. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing in accordance with ASTM E488/E488M conducted by a qualified testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.06 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Maintain equal louver blade spacing to produce uniform appearance.
- C. Heads, sills, jambs and mullions to be one-piece structural aluminum members. Louver consists of a 9" deep system. Louver to consist of a horizontal front blade and a vertical rear blade in a drainable frame. Louvers to be supplied with 4" high by full depth sill flashings formed from minimum 0.050" thick aluminum. Sill flashings to have welded side panels. Louvers and sill flashings to be installed in accordance with the manufacturer's recommended procedures to ensure complete water integrity performance of the louver system. Nominal minimum material thickness to be as follows: Heads, sills, jambs and mullions: 0.081". Fixed blades: 0.080" and 0.050".

## 2.07 ALUMINUM FINISHES

- A. Finish louvers after assembly.

- B. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
  - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
  - 2. Color and Gloss: Match insulated metal panel finish.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

### **3.03 INSTALLATION**

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

### **3.04 ADJUSTING AND CLEANING**

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
  - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

**END OF SECTION 08 91 19**

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**SECTION 09 01 90.52****MAINTENANCE REPAINTING****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes maintenance repainting as follows:
  - 1. Removing existing paint.
  - 2. Patching substrates.
  - 3. Repainting.
- B. Related Requirements:
  - 1. Section 09 91 13 "Exterior Painting," and Section 09 91 23 "Interior Painting," for Paint materials and systems for new construction.

**1.02 DEFINITIONS**

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
- B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
- E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.
- H. Low-Pressure Spray: 100 to 400 psi; 4 to 6 gpm.
- I. Medium-Pressure Spray: 400 to 800 psi; 4 to 6 gpm.

### 1.03 SEQUENCING AND SCHEDULING

- A. Perform maintenance repainting in the following sequence, which includes work specified in this and other Sections:
  - 1. Dismantle existing surface-mounted objects and hardware except items indicated to remain in place. Tag items with location identification and protect.
  - 2. Verify that temporary protections have been installed.
  - 3. Examine condition of surfaces to be painted.
  - 4. Remove existing paint to the degree required for each substrate and surface condition of existing paint.
  - 5. Apply paint system.
  - 6. Reinstall dismantled surface-mounted objects and hardware unless otherwise indicated.

### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include recommendations for product application and use.
  - 2. Include test data substantiating that products comply with requirements.
- B. Samples: For each type of paint system and each pattern, color, and gloss; minimum 6 inches long in least dimension, but not less than whole pattern.
  - 1. Include stepped Samples defining each separate coat, including fillers and primers. Resubmit until each required sheen, color, and texture is achieved.
  - 2. For each painted color being matched to a standardized color-coding system, include the color chips from the color-coding-system company with Samples.
  - 3. Include a list of materials for each coat of each Sample.
  - 4. Label each Sample for location and application.
- C. Product List: For each paint product indicated, include the following:
  - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
  - 2. Printout of current "MPI Approved Products List" for each MPI-product category specified in paint systems, with the proposed product highlighted.
  - 3. VOC content.

### 1.05 INFORMATIONAL SUBMITTALS

- A. Color Matching Certificate: For computer-matched colors.

### 1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra paint materials, from the same production run, that match products applied and that are packaged with protective covering for storage and identified with labels describing contents, including material, finish, source, and location on building.
  - 1. Quantity: Furnish Owner with an additional 5 percent, but not less than 1 gal. or one case, as appropriate, of each material and color applied.

## 1.07 QUALITY ASSURANCE

- A. Color Matching: Custom computer-match paint colors to colors indicated on Drawings. For colors indicated by a standardized coding system, obtain a color chip for each color indicated from the color-coding-system company; computer match paint colors to the color chips.
- B. Mockups: Prepare mockups of maintenance repainting processes for each type of coating system and substrate indicated and each color and finish required to demonstrate aesthetic effects and to set quality standards for materials and execution. Duplicate appearance of approved Sample submittals.
  - 1. Locate mockups on existing surfaces where directed by Architect.
  - 2. Surface-Preparation Mockups: On existing surfaces using applicable specified methods of cleaning and other surface preparation, provide mockup sample of at least 100 sq. ft..
  - 3. Coating Mockups: Two surfaces of at least 100 sq. ft. to represent surfaces and conditions for application of each type of coating system under same conditions as the completed Work.
  - 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.08 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste daily.

## 1.09 FIELD CONDITIONS

- A. Weather Limitations: Proceed with maintenance repainting only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.
- B. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- C. Do not apply paint in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
  - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer for surface preparation and during paint application and drying periods.

## PART 2 - PRODUCTS

### 2.01 PREPARATORY CLEANING MATERIALS

- A. Water: Potable.

- B. Hot Water: Water heated to a temperature of 140 to 160 deg F.
- C. Detergent Solution: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSPP), 1/2 cup of laundry detergent that contains no ammonia, 5 quarts of 5 percent sodium hypochlorite bleach, and 15 quarts of warm water for every 5 gal. of solution required.
- D. Mildewcide: Commercial proprietary mildewcide or a job-mixed solution prepared by mixing 1/3 cup of household detergent that contains no ammonia, 1 quart of 5 percent sodium hypochlorite bleach, and 3 quarts of warm water.
- E. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.
- F. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

## 2.02 PAINT REMOVERS

- A. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methylene chloride.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. [American Building Restoration Products, Inc.](#)
    - b. [Diedrich Technologies, Inc.: a Hohmann & Barnard company.](#)
    - c. [EaCo Chem, Inc.](#)
- B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methylene chloride.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. [American Building Restoration Products, Inc.](#)
    - b. [Dumond Chemicals, Inc.](#)
- C. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. [Diedrich Technologies, Inc.: a Hohmann & Barnard company.](#)
    - b. [PROSOCO, Inc.](#)
    - c. [Shore Corporation.](#)



- D. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methanol or methylene chloride.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Dumond Chemicals, Inc.
    - b. PROSOCO, Inc.

## 2.03 PAINT, GENERAL

- A. Material Compatibility:
  - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

## 2.04 PAINT MATERIALS, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Transition Coat: Paint manufacturer's recommended coating for use where a residual existing coating is incompatible with the paint system.

## 2.05 PAINT MATERIALS

- A. Primers and Sealers:
  - 1. Primer, Latex, for Interior Wood: MPI #39.
- B. Metal Primers:
  - 1. Primer, Metal, Surface Tolerant: MPI #23.
  - 2. Primer, Alkyd, Anti-Corrosive for Metal: MPI #79.
- C. Wood Primers:
  - 1. Primer, Alkyd for Exterior Wood: MPI #5.
- D. Water-Based Paints:
  - 1. Latex, Exterior Semigloss (Gloss Level 5): MPI #11.
  - 2. Latex, Interior, Semigloss, (Gloss Level 5): MPI #54.
- E. Solvent-Based Paints:
  - 1. Alkyd, Exterior, Semigloss (Gloss Level 5): MPI #94.

## 2.06 PATCHING MATERIALS

- A. Wood-Patching Compound: Two-part, epoxy-resin, wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be designed for filling voids in damaged wood materials that have deteriorated from weathering and decay. Compound shall be capable of filling deep holes and spreading to feather edge.
- B. Metal-Patching Compound: Two-part, polyester-resin, metal-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of metal repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be produced for filling metal that has deteriorated from corrosion. Filler shall be capable of filling deep holes and spreading to feather edge.
- C. Cementitious Patching Compounds: Cementitious patching compounds and repair materials specifically manufactured for filling cementitious substrates and for sanding or tooling prior to repainting; formulation as recommended in writing by manufacturer for type of cementitious substrate indicated, exposure to weather and traffic, the detail of work, and site conditions.
- D. Gypsum-Plaster Patching Compound: Finish coat plaster and bonding compound according to ASTM C842 and manufacturer's written instructions.

## PART 3 - EXECUTION

### 3.01 PROTECTION

- A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
  - 1. Cover adjacent surfaces with materials that are proven to resist chemical solutions being used unless the solutions will not damage adjacent surfaces. Use protective materials that are UV resistant and waterproof. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
  - 2. Do not apply chemical solutions during winds of sufficient force to spread them to unprotected surfaces.
  - 3. Neutralize and collect alkaline and acid wastes before disposal.
  - 4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

### 3.02 MAINTENANCE REPAINTING, GENERAL

- A. Maintenance Repainting Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from building interior at 5 feet away from painted surface and from building exterior at 20 feet away from painted surface.
- B. Execution of the Work: In repainting surfaces, disturb them as minimally as possible and as follows:
  - 1. Remove failed coatings and corrosion and repaint.

2. Verify that substrate surface conditions are suitable for repainting.
  3. Allow other trades to repair items in place before repainting.
- C. Mechanical Abrasion: Where mechanical abrasion is needed for the work, use gentle methods, such as scraping and lightly hand sanding, that will not abrade softer substrates, reducing clarity of detail.
- D. Heat Processes: Do not use torches, heat guns, or heat plates.

### 3.03 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of painting work. Comply with paint manufacturer's written instructions for inspection.
- B. Maximum Moisture Content of Substrates: Do not begin application of coatings unless moisture content of exposed surface is below the maximum value recommended in writing by paint manufacturer and not greater than the following maximum values when measured with an electronic moisture meter appropriate to the substrate material:
1. Concrete: 12 percent.
  2. Gypsum Board: 12 percent.
  3. Gypsum Plaster: 12 percent.
  4. Masonry (Clay and CMU): 12 percent.
  5. Portland Cement Plaster: 12 percent.
  6. Wood: 15 percent.
- C. Alkalinity: Do not begin application of coatings unless surface alkalinity is within range recommended in writing by paint manufacturer. Conduct alkali testing with litmus paper on exposed plaster, cementitious, and masonry surfaces.
- D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
1. If existing surfaces cannot be prepared to an acceptable condition for proper finishing by using specified surface-preparation methods, notify Architect in writing.
- E. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

### 3.04 PREPARATORY CLEANING

- A. General: Use the gentlest, appropriate method necessary to clean surfaces in preparation for painting. Clean all surfaces, corners, contours, and interstices.
- B. Detergent Cleaning: Wash surfaces by hand using clean rags, sponges, and bristle brushes. Scrub surface with detergent solution and bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet. Rinse with water applied by clean rags or sponges.

- C. Solvent Cleaning: Use solvent cleaning to remove oil, grease, smoke, tar, and asphalt from painted or unpainted surfaces before other preparation work. Wipe surfaces with solvent using clean rags and sponges. If necessary, spot-solvent cleaning may be employed just prior to commencement of paint application, provided enough time is allowed for complete evaporation. Use clean solvent and clean rags for the final wash to ensure that all foreign materials have been removed. Do not use solvents, including primer thinner and turpentine, that leave residue.
- D. Mildew: Clean off existing mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. Rinse with water applied by clean rags or sponges.
- E. Chemical Rust Removal:
  - 1. Remove loose rust scale with specified abrasives for ferrous-metal cleaning.
  - 2. Apply rust remover with brushes or as recommended in writing by manufacturer.
  - 3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
  - 4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
  - 5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
  - 6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.
- F. Mechanical Rust Removal:
  - 1. Remove rust with specified abrasives for ferrous-metal cleaning. Clean to bright metal.
  - 2. Wipe off residue with mineral spirits and either steel wool or soft rags.
  - 3. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
  - 4. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

### 3.05 PAINT REMOVAL

- A. General: Remove paint where indicated. Where cleaning methods have been attempted and further removal of the paint is required because of incompatible or unsatisfactory surfaces for repainting, remove paint to extent required by conditions.
  - 1. Application: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
    - a. Apply materials to all surfaces, corners, contours, and interstices, to provide a uniform final appearance without streaks.
    - b. After work is complete, remove protection no longer required. Remove tape and adhesive marks.
  - 2. Brushes: Use brushes that are resistant to chemicals being used.
    - a. Metal Substrates: If using wire brushes on metal, use brushes of same metal composition as metal being treated.
    - b. Wood Substrates: Do not use wire brushes.
  - 3. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.

- a. Equip units with pressure gages.
  - b. Unless otherwise indicated, hold spray nozzle at least 6 inches from surface and apply material in horizontal, back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
  - c. For chemical spray application, use low-pressure tank or chemical pump suitable for chemical indicated, equipped with nozzle having a cone-shaped spray.
  - d. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
  - e. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F at flow rates indicated.
- B. Paint Removal with Hand Tools: Remove paint manually using hand-held scrapers, wire brushes, sandpaper, and metallic wool as appropriate for the substrate material.
- C. Paint Removal with Alkaline Paste Paint Remover:
1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
  2. Apply paint remover to dry, painted surface with brushes.
  3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
  4. Rinse with water applied by low or medium-pressure spray to remove chemicals and paint residue.
  5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
  6. Repeat process if necessary to remove all paint.
- D. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:
1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
  2. Apply paint remover to dry, painted surface with brushes or as recommended in writing by manufacturer.
  3. Apply cover according to manufacturer's written instructions.
  4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
  5. Scrape off paint and remover.
  6. Rinse with water applied by low or medium-pressure spray to remove chemicals and paint residue.
  7. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
  8. For spots of remaining paint, apply alkaline paste paint remover according to "Paint Removal with Alkaline Paste Paint Remover" Paragraph.
- E. Paint Removal with Solvent-Type Paste Paint Remover:
1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
  2. Apply thick coating of paint remover to dry, painted surface with natural-fiber cleaning brush, deep-nap roller, or large paintbrush. Apply in one or two coats according to manufacturer's written instructions.
  3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
  4. Rinse with water applied by low or medium-pressure spray to remove chemicals and paint residue.

5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
6. Repeat process if necessary to remove all paint.

F. Paint Removal with Covered, Solvent-Type Paste Paint Remover:

1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with water applied by low or medium-pressure spray to remove chemicals and paint residue.
7. Use mechanical methods recommended in writing by manufacturer to remove remaining chemicals and paint residue.

### 3.06 SUBSTRATE REPAIR

A. General: Repair substrate surface defects that are inconsistent with the surface appearance of adjacent materials and finishes.

B. Wood Substrate:

1. Repair wood defects including dents and gouges more than 1/8 inch in size and all holes and cracks by filling with wood-patching compound and sanding smooth. Reset or remove protruding fasteners.
2. Where existing paint is allowed to remain, sand irregular buildup of paint, runs, and sags to achieve a uniformly smooth surface.

C. Cementitious Material Substrate:

1. General: Repair defects including dents and chips more than 1/4 inch in size and all holes and cracks by filling with cementitious patching compound and sanding smooth. Remove protruding fasteners.
2. New and Bare Plaster: Neutralize surface of plaster with mild acid solution as recommended in writing by paint manufacturer. In lieu of acid neutralization, follow manufacturer's written instruction for primer or transition coat over alkaline plaster surfaces.
3. Concrete, Cement Plaster, and Other Cementitious Products: Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. If surfaces are too alkaline to paint, correct this condition before painting.

D. Gypsum-Plaster and Gypsum-Board Substrates:

1. Repair defects including dents and chips more than 1/8 inch in size and all holes and cracks by filling with gypsum-plaster patching compound and sanding smooth. Remove protruding fasteners.
2. Rout out surface cracks to remove loose, unsound material; fill with patching compound and sand smooth.

E. Metal Substrate:

1. Preparation: Treat repair locations by wire-brushing and solvent cleaning. Use chemical or mechanical rust removal method to clean off rust.
2. Defects in Metal Surfaces: Repair non-load-bearing defects in existing metal surfaces, including dents and gouges more than 1/16 inch deep or 1/2 inch across and all holes and cracks by filling with metal-patching compound and sanding smooth. Remove burrs and protruding fasteners.
3. Priming: Prime iron and steel surfaces immediately after repair to prevent flash rusting. Stripe paint corners, crevices, bolts, welds, and sharp edges. Apply two coats to surfaces that are inaccessible after completion of the Work.

### 3.07 PAINT APPLICATION, GENERAL

- A. Comply with manufacturers' written instructions for application methods unless otherwise indicated in this Section.
- B. Prepare surfaces to be painted according to the Surface-Preparation Schedule and with manufacturer's written instructions for each substrate condition.
- C. Apply a transition coat over incompatible existing coatings.
- D. Metal Substrate: Stripe paint corners, crevices, bolts, welds, and sharp edges before applying full coat. Apply two coats to surfaces that are inaccessible after completion of the Work. Tint stripe coat different than the main coating and apply with brush.
- E. Blending Painted Surfaces: When painting new substrates patched into existing surfaces or touching up missing or damaged finishes, apply coating system specified for the specific substrate. Apply final finish coat over entire surface from edge to edge and corner to corner.

### 3.08 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage paint-remover manufacturer's factory-authorized service representative for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.
- B. Paint Material Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for composition and dry film thickness.
  1. Paint Composition: The following procedure may be performed at any time and as often as Owner deems necessary during the period when paints are being applied:
    - a. Testing agency will sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
    - b. Testing agency will perform tests for compliance of paint materials with product requirements.
    - c. If test results show materials being used do not comply with product requirements, Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.
  2. Dry Film Thickness:
    - a. Contractor shall touch up and restore painted surfaces damaged by testing.

- b. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

### 3.09 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### 3.10 SURFACE-PREPARATION SCHEDULE

- A. General: Before painting, prepare surfaces for painting according to applicable requirements specified in this schedule.
  - 1. Examine surfaces to evaluate each surface condition according to paragraphs below.
  - 2. Where existing degree of soiling prevents examination, preclean surface and allow it to dry before making an evaluation.
  - 3. Repair substrate defects according to "Substrate Repair" Article.
- B. Surface Preparation for MPI DSD 0 Degree of Surface Degradation:
  - 1. Surface Condition: Existing paint film in good condition and tightly adhered.
  - 2. Paint Removal: Not required.
  - 3. Preparation for Painting: Wash surface by detergent cleaning; use solvent cleaning where needed. Roughen or degloss cleaned surfaces to ensure paint adhesion according to paint manufacturer's written instructions.
- C. Surface Preparation for MPI DSD 1 Degree of Surface Degradation:
  - 1. Surface Condition: Paint film cracked or broken but adhered.
  - 2. Paint Removal: Scrape by hand-tool cleaning methods to remove loose paint until only tightly adhered paint remains.
  - 3. Preparation for Painting: Wash surface by detergent cleaning; use other cleaning methods for small areas of bare substrate if required. Roughen, degloss, and sand the cleaned surfaces to ensure paint adhesion and a smooth finish according to paint manufacturer's written instructions.
- D. Surface Preparation for MPI DSD 2 Degree of Surface Degradation:
  - 1. Surface Condition: Paint film loose, flaking, or peeling.
  - 2. Paint Removal: Remove loose, flaking, or peeling paint film by hand-tool or chemical paint-removal methods.



3. Preparation for Painting: Wash surface by detergent cleaning; use solvent cleaning where needed. Use other cleaning methods for small areas of bare substrate if required. Sand surfaces to smooth remaining paint film edges. Prepare bare cleaned surface to be painted according to paint manufacturer's written instructions for substrate construction materials.

E. Surface Preparation for MPI DSD 3 Degree of Surface Degradation:

1. Surface Condition: Paint film severely deteriorated and surface indicated to have paint completely removed.
2. Paint Removal: Completely remove paint film by hand-tool or chemical paint-removal methods. Remove rust.
3. Preparation for Painting: Prepare bare cleaned surface according to paint manufacturer's written instructions for substrate construction materials.

F. Surface Preparation for MPI DSD 4 Degree of Surface Degradation:

1. Surface Condition: Missing material, small holes and openings, and deteriorated or corroded substrate.
2. Substrate Preparation: Repair, replace, and treat substrate according to "Substrate Repair" Article and requirements in other Specification Sections.
3. Preparation for Painting: Sand substrate surfaces to smooth remaining paint film edges and prepare according to paint manufacturer's written instructions for substrate construction materials. Remove rust.
4. Painting: Paint as required for MPI DSD 2 degree of surface degradation.

### 3.11 EXTERIOR MAINTENANCE REPAINTING SCHEDULE

A. Ferrous Metal Substrates::

1. Alkyd System: MPI REX 5.1D system.
  - a. Prime Coat: For MPI DSD 1 degree of surface degradation, touch up with topcoat.
  - b. Prime Coat: For MPI DSD 2 degree of surface degradation, spot prime with Primer, Metal, Surface Tolerant, MPI #23.
  - c. Prime Coat: For MPI DSD 3 degree of surface degradation, fully prime coat with Primer, Metal, Surface Tolerant, MPI #23.
  - d. Intermediate Coat: Alkyd, exterior, matching topcoat.
  - e. Topcoat: Alkyd, exterior, semigloss (Gloss Level 5), MPI #94.
  - f. Color: Match colors indicated on Drawings.

B. Wood:

1. Latex System: MPI REX 6.2A system.
  - a. Prime Coat: For MPI DSD 1 degree of surface degradation, touch up with topcoat.
  - b. Prime Coat: For MPI DSD 2 degree of surface degradation, spot prime with Primer, Alkyd for Exterior Wood, MPI #5.
  - c. Prime Coat: For MPI DSD 3 degree of surface degradation, fully prime coat with Primer, Alkyd for Exterior Wood, MPI #5.
  - d. Intermediate Coat: Latex, exterior, matching topcoat.
  - e. Topcoat: Latex, exterior semigloss (Gloss Level 5), MPI #11.
  - f. Color: Match colors indicated on Drawings.

### 3.12 INTERIOR MAINTENANCE REPAINTING SCHEDULE

#### A. Ferrous Metal Substrates::

1. Latex System: MPI RIN 5.1N system.
  - a. Prime Coat: For MPI DSD 1 degree of surface degradation, touch up with topcoat.
  - b. Prime Coat: For MPI DSD 2 degree of surface degradation, spot prime with Primer, Alkyd, Anti-Corrosive for Metal, MPI #79.
  - c. Prime Coat: For MPI DSD 3 degree of surface degradation, fully prime coat with Primer, Alkyd, Anti-Corrosive for Metal, MPI #79.
  - d. Intermediate Coat: Latex matching topcoat.
  - e. Topcoat: Latex, interior, semigloss (Gloss Level 5), MPI #54.
  - f. Color: Match colors indicated on Drawings.

#### B. Wood:

1. Latex System over Latex Primer: MPI RIN 6.2D system.
  - a. Prime Coat: For MPI DSD 1 degree of surface degradation, touch up with topcoat.
  - b. Prime Coat: For MPI DSD 2 degree of surface degradation, spot prime with Primer, Latex, for Interior Wood, MPI #39.
  - c. Prime Coat: For MPI DSD 3 degree of surface degradation, fully prime coat with Primer, Latex, for Interior Wood, MPI #39.
  - d. Intermediate Coat: Latex, interior, matching topcoat.
  - e. Topcoat: Latex, interior, semigloss (Gloss Level 5), MPI #54.
  - f. Color: Match colors indicated on Drawings.

**END OF SECTION 09 01 90.52**

**SECTION 09 22 16****NON-STRUCTURAL METAL FRAMING****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Non-load-bearing steel framing systems for interior partitions.

**B. Related Requirements:**

1. Section 05 40 00 "Cold-Formed Metal Framing" for interior load-bearing and wall studs; and ceiling joists.

**1.02 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For firestop tracks, post-installed anchors, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

**1.04 QUALITY ASSURANCE**

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Stud Manufacturers Association.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Notify manufacturer of damaged materials received prior to installation.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- C. Horizontal Deflection: For wall assemblies, limited to 1/360 of the wall height based on horizontal loading of 5 lbf/sq. ft..
- D. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.
- E. Design Loads: As indicated on architectural Drawings or 5 lbf/sq. ft. minimum as required by the IBC.
- F. Design framing systems to accommodate deflection of primary building structure and construction tolerances and to withstand design loads.

### 2.02 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C645 for conditions indicated.
  - 1. Steel Sheet Components: Comply with ASTM C645 requirements for metal unless otherwise indicated
  - 2. Protective Coating: Comply with ASTM C645; ASTM A653/A653M, G40. Galvannealed products are unacceptable.
- B. Studs and Track: ASTM C645.
  - 1. Minimum Base-Steel Thickness: 0.0329 inch.
  - 2. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide one of the following:
  - 1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing 1-1/2-inch (38-mm) minimum vertical movement.
  - 2. Single Long-Leg Track System: ASTM C645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
  - 3. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
  - 4. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

- D. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
  - 1. Minimum Base-Steel Thickness: 0.0329 inch.
- F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch- wide flanges.
  - 1. Depth: 1-1/2 inches.
  - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C645.
  - 1. Minimum Base-Steel Thickness: 0.0329 inch.
  - 2. Depth: As indicated on Drawings.
- H. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.
  - 1. Configuration: Asymmetrical.
- I. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges.
  - 1. Depth: 3/4 inch.
  - 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
  - 3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-steel thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

## 2.03 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
  - 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
  - 1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
  - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Coordination with Sprayed Fire-Resistive Materials:
  - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
  - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

### **3.03 INSTALLATION, GENERAL**

- A. Installation Standard: ASTM C754.
  - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
  - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
  - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
  - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

### 3.04 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
  - 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
  - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
  - 3. Tile Backing Panels: As required by horizontal deflection performance requirements unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
  - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
  - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
    - a. Install two studs at each jamb unless otherwise indicated.
    - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
  - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
  - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
    - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
  - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
  - 6. Curved Partitions:
    - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.
- E. Direct Furring:
  - 1. Screw to wood framing.
  - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c.
  2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
  3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

**END OF SECTION 09 22 16**



**SECTION 09 29 00****GYPSUM BOARD****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Interior gypsum board.
- B. Related Requirements:
  - 1. Section 09 22 16 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

**1.02 ACTION SUBMITTALS**

- A. Product Data: For the following:
  - 1. Impact-resistant gypsum board.
  - 2. Interior trim.
  - 3. Joint treatment materials.
  - 4. Sound-attenuation blankets.

**1.03 DELIVERY, STORAGE AND HANDLING**

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

**1.04 FIELD CONDITIONS**

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

### 2.02 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

### 2.03 INTERIOR GYPSUM BOARD

- A. Impact-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Certainteed; SAINT-GOBAIN.
    - b. Georgia-Pacific Gypsum LLC.
    - c. Gold Bond Building Products, LLC provided by National Gypsum Company.
    - d. USG Corporation.
  - 2. Core: 5/8 inch, Type X.
  - 3. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 2 requirements.
  - 4. Indentation: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
  - 5. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 2 requirements.
  - 6. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 2 requirements according to test in Annex A1.
  - 7. Long Edges: Tapered.
  - 8. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

### 2.04 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
  - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
  - 2. Shapes:
    - a. Cornerbead.
    - b. Bullnose bead.
    - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
    - d. L-Bead: L-shaped; exposed long flange receives joint compound.
    - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.

- f. Expansion (control) joint.
- g. Curved-Edge Cornerbead: With notched or flexible flanges.
- h. Base-of-Wall Galvanized Moisture Barrier Trim: Galvanized-steel sheet, 2 inches high.

- 1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a) VersaDry, LLC.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Fry Reglet Corporation.
  - b. Gordon Inc.
  - c. Pittcon Industries.
- 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5.
- 3. Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

## 2.05 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

- 1. Interior Gypsum Board: Paper.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

- 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
- 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping or drying-type, all-purpose compound.
  - a. Use setting-type compound for installing paper-faced metal trim accessories.
- 3. Fill Coat: For second coat, use setting-type, sandable topping or drying-type, all-purpose compound.
- 4. Finish Coat: For third coat, use setting-type, sandable topping or drying-type, all-purpose compound.
- 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

## 2.06 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

- B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
  - 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
  - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
  - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- D. Thermal Insulation: As specified in Section 07 21 00 "Thermal Insulation."

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 INSTALLATION AND FINISHING OF PANELS, GENERAL**

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.
- J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

### 3.03 INSTALLATION OF INTERIOR GYPSUM BOARD

#### A. Single-Layer Application:

1. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
  - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
  - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
2. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

#### B. Multilayer Application:

1. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
2. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

### 3.04 INSTALLATION OF TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners.
  - 2. LC-Bead: Use at exposed panel edges.
  - 3. L-Bead: Use where indicated.
- D. Aluminum Trim: Install in locations indicated on Drawings.

### 3.05 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
  - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
  - 2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
    - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."

### 3.06 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**END OF SECTION 09 29 00**

**SECTION 09 51 13****ACOUSTICAL PANEL CEILINGS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

**1.02 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Ceiling suspension-system members.
  - 2. Structural members to which suspension systems will be attached.
  - 3. Method of attaching hangers to building structure.
  - 4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
  - 5. Size and location of initial access modules for acoustical panels.
  - 6. Items penetrating finished ceiling and ceiling-mounted items including the following:
    - a. Lighting fixtures.
    - b. Diffusers.
    - c. Grilles.
    - d. Speakers.
    - e. Sprinklers.
    - f. Access panels.
    - g. Perimeter moldings.
  - 7. Minimum Drawing Scale: 1/4 inch = 1 foot.
- B. Qualification Data: For testing agency.
- C. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.
- D. Field quality-control reports.

#### 1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

#### 1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
  - 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

#### 1.06 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Build mockup of typical ceiling area as shown on Drawings.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

#### 1.08 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
  - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.



## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

### **2.02 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer to design seismic restraints for ceiling systems.
- B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: Class A according to ASTM E1264.
  - 2. Smoke-Developed Index: 450 or less.

### **2.03 ACOUSTICAL PANELS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Armstrong Ceiling & Wall Solutions.
  - 2. Certainteed; SAINT-GOBAIN.
  - 3. USG Corporation.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Classification: Provide panels as follows:
  - 1. Type and Form: Type XX, high-density, ceramic- and mineral-base panels with scrubbable finish, resistant to heat, moisture, and corrosive fumes.
  - 2. Pattern: CE (perforated, small holes and lightly textured).
- D. Color: White.
- E. Light Reflectance (LR): Not less than 0.75.
- F. Ceiling Attenuation Class (CAC): Not less than 40.
- G. Noise Reduction Coefficient (NRC): Not less than 0.55.
- H. Edge/Joint Detail: Square.
- I. Thickness: 5/8 inch.

- J. Modular Size: 24 by 24 inches.
- K. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D3273, ASTM D3274, or ASTM G21 and evaluated according to ASTM D3274 or ASTM G21.

#### 2.04 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Armstrong Ceiling & Wall Solutions.
  - 2. Certainteed; SAINT-GOBAIN.
  - 3. USG Corporation.
- B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.
- C. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 15/16-inch- wide metal caps on flanges.
  - 1. Structural Classification: Heavy-duty system.
  - 2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
  - 3. Face Design: Flat, flush.
  - 4. Cap Material: Cold-rolled steel.
  - 5. Cap Finish: Painted white.

#### 2.05 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
  - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E488/E488M or ASTM E1512 as applicable, conducted by a qualified testing and inspecting agency.
    - a. Type: Postinstalled expansion or postinstalled bonded anchors.
    - b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B633, Class SC 1 (mild) service condition.
  - 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E1190, conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
  2. Stainless-Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
  3. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- diameter wire.
- C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch- thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 coating designation; with bolted connections and 5/16-inch- diameter bolts.
- F. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.
- G. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- H. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

### **3.03 INSTALLATION**

- A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer's written instructions.

- B. Suspend ceiling hangers from building's structural members and as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
  5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
  6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  8. Do not attach hangers to steel deck tabs.
  9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
  11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
  2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
  2. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

### 3.04 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

### 3.05 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  - 1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.
  - 1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
  - 2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.06 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

**END OF SECTION 09 51 13**

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**SECTION 09 67 23****RESINOUS FLOORING****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Resinous flooring.
  - 2. Integral cove base accessories.

**1.02 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review manufacturer's written instructions for substrate preparation and environmental conditions affecting resinous flooring installation.
  - 2. Review details of integral cove bases.
  - 3. Review manufacturer's written instructions for installing resinous flooring systems.
  - 4. Review protection measures for adjacent construction and installed flooring, floor drainage requirements, curbs, base details, and so forth.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include manufacturer's technical data, installation instructions, and recommendations for each resinous flooring component required.
- B. Samples: For each resinous floor system required and for each color and texture specified, 6 inches square in size, applied to a rigid backing by Installer for this Project.
- C. Samples for Initial Selection: For each type of exposed finish required.
- D. Samples for Verification: For each resinous flooring system required and for each color and texture specified, 6 inches square, applied to a rigid backing by Installer for this Project.

**1.04 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Material Certificates: For each resinous flooring component.
- C. Material Test Reports: For each resinous flooring system, by a qualified testing agency.
- D. Field quality-control reports.

#### 1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For resinous flooring to include in maintenance manuals.

#### 1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
  - 1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Apply full-thickness mockups on 96-inch- square floor area selected by Architect.
    - a. Include 96-inch length of integral cove base with inside and outside corner.
  - 2. Simulate finished lighting conditions for Architect's review of mockups.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

#### 1.08 FIELD CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring installation.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring installation.
- C. Close spaces to traffic during resinous flooring installation and for 24 hours after installation unless manufacturer recommends a longer period.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Flammability: Self-extinguishing in accordance with ASTM D635.



## 2.02 RESINOUS FLOORING

- A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.
  - 1. Products of Tnemec Co., Inc., Compton Ca, 90222. Tel # 310-637-2363. Contact: Tony Hobbs, are listed to establish a standard of performance and quality
- B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.
- C. System Characteristics:
  - 1. Color and Pattern: As selected by Architect from manufacturer's full range.
  - 2. Wearing Surface: Manufacturer's standard wearing surface.
  - 3. Overall System Thickness: 36 to 48 mils.

## 2.03 MATERIALS

- A. Tnemec Series 208 Epoxoprime MVT
  - 1. Volume Solids: 100%
  - 2. VOC: 11 grams/litre
  - 3. HAPS: 0.0 lbs/gal solids
- B. Tnemec Series 237 Power-Tread
  - 1. Volume Solids: 100%
  - 2. VOC: 30 grams/litre
  - 3. HAPS: 0.0 lbs/gal solids
- C. Tnemec Series 230ESD Static-Shield EP
  - 1. Volume Solids: 100%
  - 2. VOC: 12 grams/litre
- D. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction.

## 2.04 ACCESSORY MATERIALS

- A. Patching and Fill Material: Resinous product of or approved by manufacturer and recommended by manufacturer for application indicated.
- B. Joint Sealant: Type recommended or produced by manufacturer for type of service and joint condition indicated.

## 2.05 INTEGRAL COVE BASE ACCESSORIES

- A. Precast, Integral Cove Base: Impact-resistant, polymer-resin, cove base moldings with a grit profile to promote adhesion of resinous flooring and recommended in writing by resinous flooring manufacturer.
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Easy Cove
    - b. Speed Cove
  - 2. Radius Cove Base: 4-inch- high base molding that provides approximately 1-inch radius cove at floor-to-wall joint; for adhesive installation as substrate for resinous flooring system to form an integral cove base.
    - a. Preformed Inside and Outside Corners: Provide manufacturer's standard square inside and 3/4- to 1-inch bullnose outside corners.
- B. Installation Adhesive: As recommended in writing by accessory manufacturer.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resinous flooring systems.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Prepare and clean substrates in accordance with resinous flooring manufacturer's written instructions for substrate indicated to ensure adhesion.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
  - 1. Roughen concrete substrates as follows:
    - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
    - b. Comply with requirements in SSPC-SP 13/NACE No. 6, with a Concrete Surface Profile of 3 or greater in accordance with ICRI Technical Guideline No. 310.2R, unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete in accordance with resinous flooring manufacturer's written instructions.
  3. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
  4. Alkalinity and Adhesion Testing: Perform tests recommended in writing by resinous flooring manufacturer. Proceed with installation only after substrate alkalinity is not less than 6 or more than 8 pH unless otherwise recommended in writing by flooring manufacturer,
- C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates in accordance with manufacturer's written instructions.
1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring in accordance with manufacturer's written instructions.
- D. Resinous Materials: Mix components and prepare materials in accordance with resinous flooring manufacturer's written instructions.

### 3.03 INSTALLATION

- A. Apply components of resinous flooring system in accordance with manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness specified.
1. Coordinate installation of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
  2. Cure resinous flooring components in accordance with manufacturer's written instructions. Prevent contamination during installation 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 products in accordance with Manufacturer's written instruction as outlined in application guides and product data sheets.
- C. Comply with manufacturer's written instructions for mixing and preparing materials and as applicable to substrates.
- D. Terminations shall be installed in accordance with the StrataShield Standard Flooring Details Guide:
- E. Areas not to receive resinous floor coating system shall be masked or otherwise protected to prevent these surfaces from being coated.
- F. Surface Temperature: Prior to application, the surface temperature shall be per manufacturer's written recommendations.

- G. Material Temperature: Prior to application, the material temperature shall be per manufacturer's written recommendations or between 65 degrees F and 85 degrees F. The material shall be stored at these temperatures at least 48 hours prior to use.
- H. Apply resinous floor coatings according to manufacturer's written instructions. Use applicators and techniques suited for resinous floor coatings and substrate indicated.
- I. Apply each material at not less than manufacturer's recommended spreading rate. Provide total cured material thickness indicated or as recommended in writing by manufacturer.
- J. Integral Cove Base Accessories: Adhesively install precast accessories before applying flooring coats and in accordance with manufacturer's written instructions.

#### 3.04 FIELD QUALITY CONTROL

- A. Material Sampling: Owner may, at any time and any number of times during resinous flooring installation, require material samples for testing for compliance with requirements.
  - 1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
  - 2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
  - 3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reinstall flooring materials to comply with requirements.
- B. Core Sampling: At Owner's direction and at locations designated by Owner, take one core sample per 1000 sq. ft. of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring. Correct deficiencies in installed flooring as indicated by testing.

#### 3.05 PROTECTION

- A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

#### 3.06 COATING SCHEDULE

- A. Surface Preparation: Prepare in accordance with SSPC-13/NACE 6 and ICRI Technical Guidelines. Abrasive Blast, shot-blast or mechanically abrade concrete surfaces to provide a minimum ICRI-CSP 4 or greater surface profile.
  - 1. Prime Coat: Tnemec Series 208 Epoxoprime MVT at 16 - 20 mils dry-film thickness (DFT) per coat.
  - 2. Intermediate Coat: Tnemec Series 237 Power-Tread at 8 - 12 mils DFT per coat.
  - 3. Topcoat: Tnemec Series 230ESD Static-Shield EP at 12 - 16 mils DFT per coat.

**END OF SECTION 09 67 23**

**SECTION 09 91 13****EXTERIOR PAINTING****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Surface preparation and application of paint systems on the following exterior substrates:
  - a. Steel and iron.
  - b. Galvanized metal.

**B. Related Requirements:**

1. Section 05 50 00 "Metal Fabrications" for shop priming metal fabrications.

**1.02 DEFINITIONS**

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
- B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
- D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

**1.03 ACTION SUBMITTALS****A. Product Data: For each type of product.**

1. Include preparation requirements and application instructions.
2. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
3. Indicate VOC content.

**B. Samples: For each type of topcoat product.****C. Samples for Initial Selection: For each type of topcoat product.**

- D. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches square.
  - 2. Apply coats on Samples in steps to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

#### 1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

#### 1.05 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Sherwin-Williams Company (The).
  - 2. Benjamin Moore & Co.
  - 3. Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company).
  - 4. Kelly-Moore Paints.
  - 5. Pratt & Lambert; a subsidiary of The Sherwin-Williams Company.
  - 6. Valspar; a brand of The Sherwin-Williams Company.
  - 7. Vista Paint Corporation.
- B. Products: Subject to compliance with requirements, provide product listed in the Exterior Painting Schedule for the paint category indicated.
- C. Source Limitations: Obtain paint from single source from single manufacturer.

## 2.02 PAINT PRODUCTS

- A. MPI Standards: Provide products complying with MPI standards indicated and listed in its "MPI Approved Products List."
- B. Material Compatibility:
  - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - 2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As selected by Architect from manufacturer's full range.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
  - 1. Application of coating indicates acceptance of surfaces and conditions.

### 3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
  - 1. SSPC-SP 2.

2. SSPC-SP 3.
3. SSPC-SP 7/NACE No. 4.
4. SSPC-SP 11.

- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

### 3.03 INSTALLATION

- A. Apply paints in accordance with manufacturer's written instructions and recommendations in "MPI Manual."
1. Use applicators and techniques suited for paint and substrate indicated.
  2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
  3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
  4. Paint entire exposed surface of window frames and sashes.
  5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  6. Primers specified in the Exterior Painting Schedule may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

### 3.04 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
  2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.



### 3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
  - 1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
  - 2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
  - 3. Allow empty paint cans to dry before disposal.
  - 4. Collect waste paint by type and deliver to recycling or collection facility.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### 3.06 EXTERIOR PAINTING SCHEDULE

- A. Steel and Iron Substrates:
  - 1. Water-Based Light Industrial Coating System MPI EXT 5.1B:
    - a. Zinc-Rich Prime Coat: Primer, zinc rich, inorganic, MPI #19.
    - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
    - c. Semigloss Topcoat: Light industrial coating, exterior, water based, semigloss (MPI Gloss Level 5), MPI #163.
- B. Galvanized-Metal Substrates:
  - 1. Latex System MPI EXT 5.3H:
    - a. Water-Based Prime Coat: Primer, galvanized, water based, MPI #134.
    - b. Intermediate Coat: Latex, exterior, matching topcoat.
    - c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.
  - 2. Water-Based Light Industrial Coating System MPI EXT 5.3J:
    - a. Acrylic Prime Coat: Primer, galvanized, water based, MPI #134.
    - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
    - c. Semigloss Topcoat: Light industrial coating, exterior, water based, semigloss (MPI Gloss Level 5), MPI #163.

**END OF SECTION 09 91 13**

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**SECTION 09 91 23****INTERIOR PAINTING****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes surface preparation and the application of paint systems on interior substrates.
  - 1. Concrete masonry units (CMUs).
  - 2. Wood.
  - 3. Gypsum board.
- B. Related Requirements:
  - 1. Section 05 12 00 "Structural Steel Framing" for shop priming structural steel.
  - 2. Section 05 50 00 "Metal Fabrications" for shop priming metal fabrications.
  - 3. Section 09 96 00 "High-Performance Coatings" exterior steel.

**1.02 DEFINITIONS**

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
  - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
  - 2. Indicate VOC content.

- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches square.
  - 2. Apply coats on Samples in steps to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- C. Product List: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

#### 1.04 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
    - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
    - b. Other Items: Architect will designate items or areas required.
  - 2. Final approval of color selections will be based on mockups.
    - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

#### 1.06 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Sherwin-Williams Company (The).
  - 2. Benjamin Moore & Co.
  - 3. Dunn-Edwards Corporation (a Nippon Paint Holdings Co. Ltd. company).
  - 4. Kelly-Moore Paints.
  - 5. Pratt & Lambert; a subsidiary of The Sherwin-Williams Company.
  - 6. Valspar; a brand of The Sherwin-Williams Company.
  - 7. Vista Paint Corporation.

### **2.02 PAINT, GENERAL**

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."
- B. Material Compatibility:
  - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As selected by Architect from manufacturer's full range.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
  - 1. Concrete: 12 percent.
  - 2. Masonry (Clay and CMUs): 12 percent.
  - 3. Wood: 15 percent.
  - 4. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
  - 1. Application of coating indicates acceptance of surfaces and conditions.

### 3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
  - 1. SSPC-SP 3.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Wood Substrates:
  - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
  - 2. Sand surfaces that will be exposed to view, and dust off.
  - 3. Prime edges, ends, faces, undersides, and backsides of wood.
  - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

### 3.03 INSTALLATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
  - 1. Use applicators and techniques suited for paint and substrate indicated.
  - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
  - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

### 3.04 FIELD QUALITY CONTROL

- A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.
  - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
  - 2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

### 3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### 3.06 INTERIOR PAINTING SCHEDULE

#### A. Concrete Substrates, Nontraffic Surfaces:

1. High-Performance Architectural Latex System, MPI INT 3.1C:
  - a. Prime Coat: Primer, alkali resistant, water based, MPI #3.
  - b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
  - c. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.

#### B. CMU Substrates:

1. High-Performance Architectural Latex System, MPI INT 4.2D:
  - a. Block Filler: Latex, interior/exterior, MPI #4.
  - b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
  - c. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.

#### C. Steel Substrates:

1. Alkyd System, MPI INT 5.1E:
  - a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76 or shop primer specified in Section where substrate is specified.
  - b. Intermediate Coat: Alkyd, interior, matching topcoat.
  - c. Topcoat: Alkyd, interior, semigloss (MPI Gloss Level 5), MPI #47.

#### D. Galvanized-Metal Substrates:

1. Alkyd Dry-Fall System, MPI INT 5.3P:
  - a. Prime Coat: Primer, galvanized, water based, MPI #134.
  - b. Intermediate Coat: Alkyd, interior, matching topcoat.
  - c. Topcoat: Dry fall, alkyd, semigloss (MPI Gloss Level 5), MPI #225.

#### E. Gypsum Board Substrates:

1. High-Performance Architectural Latex System, MPI INT 9.2B:
  - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
  - b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
  - c. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.

**END OF SECTION 09 91 23**



**SECTION 09 96 00****HIGH-PERFORMANCE COATINGS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes surface preparation and the application of high-performance coating systems.

1. Exterior Substrates:

- a. Steel.
- b. Galvanized metal.

- B. Related Requirements:

1. Section 09 91 23 "Interior Painting" for general field painting.

**1.02 DEFINITIONS**

- A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
  - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
  - 2. Indicate VOC content.
- B. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

**1.04 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Coatings: 5 percent, but not less than 1 gal. of each material and color applied.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

#### 1.06 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior coatings in snow, rain, fog, or mist.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Tnemec Company, Inc.
  - 2. Carboline
  - 3. Sherwin-Williams Company (The).

#### 2.02 HIGH-PERFORMANCE COATINGS, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
  - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
  - 3. Products shall be of same manufacturer for each coat in a coating system.

#### 2.03 SOURCE QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
  - 1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating

materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.

2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
  1. Application of coating indicates acceptance of surfaces and conditions.

### **3.02 PREPARATION**

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
  1. SSPC-SP 6/NACE No. 3.
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

### 3.03 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
  - 1. Use applicators and techniques suited for coating and substrate indicated.
  - 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
- B. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

### 3.04 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
  - 1. Contractor shall touch up and restore coated surfaces damaged by testing.
  - 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

### 3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

### 3.06 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. Steel Substrates:
  - 1. Pigmented Polyurethane over Epoxy Zinc-Rich Primer System MPI EXT 5.1P:
    - a. Prime Coat: Primer, zinc rich, epoxy, MPI #20.
    - b. Intermediate Coat: Epoxy, gloss, MPI #77.
    - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.
- B. Galvanized-Metal Substrates:

1. Pigmented Polyurethane over Epoxy Primer System MPI EXT 5.3L:
  - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
  - b. Intermediate Coat: Polyurethane, two component, pigmented, gloss matching topcoat.
  - c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6), MPI #72.

**END OF SECTION 09 96 00**

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**SECTION 10 28 00****TOILET, BATH, AND LAUNDRY ACCESSORIES****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Public-use washroom accessories.
  - 2. Underlavatory guards.
  - 3. Custodial accessories.

**1.02 COORDINATION**

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- B. Samples: For each exposed product and for each finish specified, full size.
  - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
  - 1. Identify locations using room designations indicated.
  - 2. Identify accessories using designations indicated.

**1.04 INFORMATIONAL SUBMITTALS**

- A. Sample Warranty: For manufacturer's special warranties.

## 1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

## 1.06 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, visible silver spoilage defects.
  - 2. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Toilet-Compartment Occupancy-Indicator Systems: Manufacturer agrees to repair or replace toilet-compartment occupancy-indicator systems that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Hand Dryers: Manufacturer agrees to repair or replace hand dryers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 PUBLIC-USE WASHROOM ACCESSORIES

- A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.
- B. Toilet Tissue (Roll) Dispenser (TA02):
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. BobrickB-2888 (Basis of design).
  - 2. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
  - 3. Mounting: Surface mounted.
  - 4. Operation: Noncontrol delivery with standard spindles (2).
  - 5. Capacity: Designed for up to 5-1/4-inch diameter tissue rolls.
  - 6. Material and Finish: 22-gauge, stainless steel, ASTM A480/A480M No. 4 finish (satin).
- C. Paper Towel (Folded) Dispenser (TA03):
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Bobrick B-359039 (basis of design).
  - 2. Mounting: Surface mounted.



3. Minimum Capacity: 300 C-fold or 400 multifold towels.
4. Material and Finish: 22-gauge, stainless steel, ASTM A480/A480M No. 4 finish (satin). Door shall be 18-gauge.
5. Lockset: Tumbler type.

D. Soap Dispenser (TA05):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Bobrick B-2111 (basis of design).
2. Description: Designed for manual operation and dispensing soap in liquid or lotion form.
3. Mounting: Vertically oriented, surface mounted.
4. Capacity: 40 fl. oz.
5. Materials: Type-304, 22-gauge stainless steel with satin-finish construction. Valve shall be black molded plastic push button and spout. Soap head-holding mushroom valve. Stainless steel spring.
6. Lockset: Tumbler type.

E. Grab Bar (TA07):

1. Mounting: Flanges with exposed fasteners.
2. Material: Stainless steel, 0.05 inch thick.
  - a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin).
3. Outside Diameter: 1-1/2 inches.
4. Configuration and Length: As indicated on Drawings.

F. Sanitary-Napkin and Tampon Vendor (TA0?):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Bobrick B-2706C (basis of design).
2. Mounting: Surface mounted.
3. Capacity: 30 tampons, 20 napkins.
4. Operation: No coin (free).
5. Exposed Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
6. Lockset: Tumbler type with separate lock and key for coin box.

G. Sanitary-Napkin Disposal Unit (TA0?):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Bobrick B-254 (basis of design).
2. Mounting: Surface mounted.
3. Door or Cover: Self-closing, disposal-opening cover and hinged face panel with tumbler lockset.
4. Receptacle: Removable, leak-proof, 1/2 gal. plastic receptacle.
5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

H. Seat-Cover Dispenser (TA01):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Bobrick B-221 (Basis of Design).
2. Mounting: Surface mounted.
3. Minimum Capacity: 250 seat covers.
4. Exposed Material and Finish: 22-gauge stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Lockset: Tumbler type.

I. Mirror Unit (TA06):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Bobrick, B-2906 (basis of design).
2. Frame: Stainless steel angle, 0.05 inch thick.
  - a. Corners: Manufacturer's standard.
3. Size: As indicated on Drawings.
4. Hangers: Manufacturer's standard rigid, tamper and theft resistant.

J. Hook:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Bobrick B-76717 (Basis of design)
2. Description: Single-prong unit.
3. Mounting: Concealed.
4. Material and Finish: 22-gauge with 14-gauge cap, stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.02 UNDERLAVATORY GUARDS

A. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

2.03 CUSTODIAL ACCESSORIES

- A. Source Limitations: Obtain each type of custodial accessory from single source from single manufacturer.

B. Custodial Mop and Broom Holder:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Bobrick, B-224 (basis of design).
2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
3. Length: 36 inches.
4. Hooks: Three.
5. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
  - a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
  - b. Rod: Approximately 1/4-inch- diameter stainless steel.

2.04 MATERIALS

- A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch- minimum nominal thickness unless otherwise indicated.
- B. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 hot-dip zinc coating.
- C. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.
- D. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.
- E. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.05 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

**PART 3 - EXECUTION**

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
  1. Remove temporary labels and protective coatings.

3.02 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

**END OF SECTION 10 28 00**

**SECTION 10 44 16****FIRE EXTINGUISHERS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

**1.02 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Warranty: Sample of special warranty.

**1.04 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

**1.05 COORDINATION**

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

**1.06 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
    - b. Faulty operation of valves or release levers.
  - 2. Warranty Period: Six years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
  - 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

### 2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
  - 1. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
  - 2. Valves: Manufacturer's standard.
  - 3. Handles and Levers: Manufacturer's standard.
  - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 2-A:10-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
- C. Clean-Agent Type in Brass Container: UL-rated 2-A:10-B:C, 15.5-lb nominal capacity, with HCFC Blend B agent and inert material in chrome-plated-brass container; with pressure-indicating gage.

### 2.03 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
  - 1. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
  - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
    - a. Orientation: Vertical.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine fire extinguishers for proper charging and tagging.
  - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
  - 1. Mounting Height: Top of fire extinguisher to be at 42 inches above finished floor.

**END OF SECTION 10 44 16**

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## SECTION 10 71 13.19 – ROLLING EXTERIOR SHUTTERS

### PART 1 - GENERAL

#### 1.01 SUMMARY

A. Section Includes:

1. Exterior Hurricane Rolling Shutters.

B. Related Requirements:

1. Section 06 10 00 - Rough Carpentry; for rough opening and blocking required for installation of shutters.
2. Section 08 51 13 – Aluminum Windows.

#### 1.02 ACTION SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

B. Shop Drawings: Include details of construction and relationship with adjacent construction.

C. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) long representing actual product, color, and patterns.

#### 1.03 CLOSEOUT SUBMITTALS

A. Operating and maintenance data.

#### 1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5 year experience manufacturing similar products.

B. Installer Qualifications: Minimum 2 year experience installing similar products.

#### 1.05 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to starting work of this section.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.
- B. Handling: Handle materials to avoid damage.

#### 1.07 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

#### 1.08 SEQUENCING

- A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

#### 1.09 WARRANTY

- A. Warranty: Provide manufacturer's standard limited warranty.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Acceptable Manufacturer: heroal USA Inc., which is located at: 7022 TPC Dr. Suite 100; Orlando, FL 32822; Toll Free Tel: 888-437=6257; Email: request info ([info@heroal.us](mailto:info@heroal.us)); Web: <https://www.heroal.de/us>
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

#### 2.02 EXTERIOR HURRICANE ROLLER SHUTTERS

- A. Performance Requirements:
  - 1. Florida Building Code - High Velocity Hurricane Zone.
  - 2. Texas Dept. of Insurance, TAS 201, TAS 202, and TAS 203.
  - 3. Tested per the Following:
    - a. ASTM E330.
    - b. ASTM E1886.
    - c. ASTM E1996.
- B. Slats; Hurricane Roller Shutters:
  - 1. Model RS 53 RC 2 (Cat. D): Highly durable and secure due to 14 mm nominal thickness.

a. System Dimensions and Properties:

- 1) Material: Extruded aluminum alloy.
  - a) Roll-formed Wall Thickness: As standard with manufacturer.
  - b) Slat Fill: Polyurethane foam with melamin resin.
- 2) Coverage Width: 2 inches (51 mm).
- 3) Slat Thickness: 0.55 inch (14 mm).
- 4) Overall Dimensions:
  - a) Maximum Width: 216.53 inch (5500 mm).
  - b) Maximum Height: 157.48 inch (4000 mm).
  - c) Maximum Area: 177.60 sq ft (16.5 sq m).
- 5) Finished Curtain Weight: 2.15 lbs per sq ft (10.5 kg per sq m).
- 6) Optimized Noise Insulation: Plus 10 dB.
- 7) Wind Load Resistance Class Per EN 13241: 6. With 106.3 inch (2700 mm) element width and a guide with 1 inch (25 mm) immersion depth.
- 8) Enhanced Burglary Resistance: RC 2 Per DIN 1627.
- 9) Hail Class: 6. Per VKF (Swiss Association of Cantonal Fire Insurance Companies) Test Specifications No. 02. The value reflects the mechanical functional capability.

b. Design Options:

- 1) Highly weather-resistant surface with 2-layer thick coating.
- 2) Color: As determined by the Architect from manufacturer's selection.

2. Model RS 53 RC 3 (Cat. E): Extremely high resistance level.

a. System Dimensions and Properties:

- 1) Material: High-grade steel alloy.
  - a) Roll-formed Wall Thickness: As standard with manufacturer.
  - b) Slat Fill: Polyurethane foam.
- 2) Coverage Width: 2 inches (51 mm).
- 3) Slat Thickness: 0.55 inch (14 mm).
- 4) Overall Dimensions:
  - a) Maximum Width: 236.22 inch (6000 mm).
  - b) Maximum Height: 157.48 inch (4000 mm).
  - c) Maximum Area: 193.75 sq ft (18.0 sq m).
- 5) Finished Curtain Weight: 3.69 lbs per sq ft (18.0 kg per sq m).
- 6) Optimized Noise Insulation: Plus 10 dB.
- 7) Wind Load Resistance Class Per EN 13241: 6. With 106.3 inch (2700 mm) element width and a guide with 1 inch (25 mm) immersion depth.
- 8) Available Resistance Class: Up to RC 3 Per DIN 1627.
- 9) Hail Class: 7. Per VKF (Swiss Association of Cantonal Fire Insurance Companies) Test Specifications No. 02. The value reflects the mechanical functional capability.

- b. Design Option:
  - 1) Highly weather-resistant surface with 2-layer thick coating.
  - 2) Color: As determined by the Architect from manufacturer's selection.
- 3. Model RS 55 SL: Security roller shutter slat with burglary resistance.
  - a. System Dimensions and Properties:
    - 1) Material: Extruded aluminum alloy.
      - a) Roll-formed Wall Thickness: As standard with manufacturer.
      - b) Slat Fill: Polyurethane foam.
    - 2) Coverage Width: 2.16 inches (55 mm).
    - 3) Slat Thickness: 0.55 inch (14 mm).
    - 4) Overall Dimensions:
      - a) Maximum Width: 196.85 inch (5000 mm).
      - b) Maximum Height: 157.48 inch (4000 mm).
      - c) Maximum Area: 66.74 sq ft (12.0 sq m).
    - 5) Finished Curtain Weight: 1.11 lbs per sq ft (5.4 kg per sq m).
    - 6) Optimized Noise Insulation: Plus 10 dB.
    - 7) Wind Load Resistance Class Per EN 13241: 5. With 106.3 inch (2700 mm) element width and a guide with 1 inch (25 mm) immersion depth.
    - 8) Burglary Resistance: In accordance with technical directive TR 111 from the BVRS (German federal association for manufacturers of roller shutters and sun protection).
    - 9) Hail Class: 5. Per VKF (Swiss Association of Cantonal Fire Insurance Companies) Test Specifications No. 02. The value reflects the mechanical functional capability.
  - b. Design Options:
    - 1) Used in Roller Shutters or Roller Doors.
    - 2) Elegant slat design.
    - 3) Highly weather-resistant surface with 2-layer thick coating.
    - 4) Color: As determined by the Architect from manufacturer's selection.
- C. Enclosures; Hurricane Resistant:
  - 1. Model GKSE:
    - a. Material: high quality aluminum alloy. Two box ends and two panel parts.
      - 1) Wall Thicknesses: 1/8 inch (3 mm) thick minimum.
      - 2) Lower panel elegantly beveled at a 45 degree angle.
    - b. Hurricane, burglar, and weather resistant.
    - c. Security: Watertight closure of the inspection cover in the upper area.
      - 1) Security lock.

- d. Soundproofing: Reduces the noise levels caused by the winding process, as opposed to boxless installation.
  - e. Box Ends: Powder coated Aluminum die castings.
  - f. High-quality hwr powder coating.
  - g. Color: \_\_\_\_\_.
  - h. Color: As determined by the Architect from manufacturer's selection.
  - i. Color: As determined by the Architect from the RAL color selection.
- 2. Box Size: 8 inch (203 mm).
  - 3. Box Size: 9 inch (229 mm).
  - 4. Box Size: 10 inch (254 mm).
  - 5. Box Size: 11.8 inch (300 mm).

**D. Accessories:**

- 1. End Slats: Heavy-duty and forms a tight seal.
  - a. Energy Saving: Tightly closing end slats provide thermal insulation and therefore savings on energy costs.
  - b. Security:
    - 1) Heavy-duty, extruded aluminum end slats.
    - 2) Unhindered winding up of curtain thanks to backstop function.
    - 3) Security option: possibility to slide in flat steel Soundproofing.
  - c. Soundproofing: Optimized noise insulation: Plus 10 dB.
  - d. Design:
    - 1) Hidden backstop.
    - 2) Stopping block.
    - 3) Backstop with angled end slat.
  - e. Finish:
    - 1) High-quality hwr powder coating.
    - 2) Color: As selected by the Architect from manufacturer's wide selection.
- 2. Guide Rails:
  - a. Energy Saving: Guide rails prevent thermal bridges between roller shutters and window frames, and the associated energy losses.
  - b. Security:
    - 1) Particularly durable, extruded aluminum guide rails.
    - 2) Reliable curtain movement thanks to rolled-in weather strip made from hard and soft PVC or brush inserts.
    - 3) Durable curtain frame.
  - c. Soundproofing: Quiet curtain operation.
  - d. Design:
    - 1) Design flexibility thanks to extensive range of variants.
    - 2) Design variants for integrated insect screen.
  - e. Finish:

- 1) High-quality hwr powder coating.
- 2) Color: As selected by the Architect from manufacturer's wide selection.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

#### **3.02 PREPARATION**

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

#### **3.03 INSTALLATION**

- A. Install in accordance with manufacturer's instructions, approved submittals and in proper relationship with adjacent construction.
- B. Test for proper operation and adjust until satisfactory results are achieved.

#### **3.04 FIELD QUALITY CONTROL**

- A. Test for proper operation and adjust until satisfactory results are obtained.

#### **3.05 PROTECTION**

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

#### **3.06 PRODUCT MAINTENANCE AND USE**

- A. Proper maintenance measures shall be taken to ensure a long life for the shutter product. The following cleaning conditions shall be met to qualify for product warranty consideration:
  1. Documented cleaning, two times per calendar year.
  2. Mild alkaline detergent and clean water wash.
  3. Effect may be increased by rubbing with a soft, non-scratch cotton cloth.
  4. Temperature of parts should not exceed 80 degrees F (26.7 degrees C) during cleaning.
  5. Use only isopropyl alcohol for removal of grease or oily substances.
  6. Cleaning solution must not be allowed to react for more than one hour.

7. After cleaning, all surfaces should be thoroughly rinsed with clean, cold water.
8. Thoroughly cleaned and lubricated yearly to maintain smooth, trouble free operation.

**END OF SECTION 10 71 13.19**

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**SECTION 10 73 13****AWNINGS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Fixed custom awnings.

**1.02 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include styles, material descriptions, construction details, fabrication details, dimensions of individual components and profiles, hardware, fittings, mounting accessories, features, and finishes for awnings.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, mounting heights, and attachment details.
  - 2. Detail fabrication and assembly of awnings
  - 3. Show locations for blocking, reinforcement, and supplementary structural support.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Verification: For the following:
  - 1. Submit one sample minimum 24-inch long of each material to be utilized at each awning with appropriate finish.
- E. Submit color chips for approval.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.
- B. Sample Warranty: For special warranty.

**1.04 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For awnings to include in operation and maintenance manuals.

#### 1.05 QUALITY ASSURANCE

- A. Single subcontract responsibility: Subcontract the work to a single firm that has had not less than ten years' experience in the design and manufacturing of work similar to that shown and required. For quality and delivery control, awnings must be purchased from a single source. Sub-contracting of awning assembly is not acceptable.
- B. Performance
  - 1. Design awnings to accommodate local requirements for snow and wind loading. Provide engineering calculations to support design. Calculations to be by a registered engineer licensed in the state the project is located. Analysis to include all components of awning including but not limited to capacity and deflection. Deflection to be limited to  $L/120$ ,  $\frac{3}{4}$ ", or as required by code.
- C. Professional Engineer Requirements: Structural calculations to be signed and sealed by a professional engineer licensed to practice in the project state.
- D. Warranty: Provide written warranty to the owner that all products will be free of defective materials or workmanship for a period of one year from date of installation.
- E. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Delivery: At the time of delivery all materials shall be visually inspected for damage. Any damaged boxes, crates, louver sections, etc. shall be noted on the receiving ticket and immediately reported to the shipping company and the material manufacturer.
- B. Storage:
  - 1. Material may be stored flat, on end or on its side.
  - 2. Material may be stored either indoors or outdoors.
  - 3. If stored outdoors the material must be raised sufficiently off the ground to prevent it being flooded.
  - 4. If stored outdoors the material must be covered with a weather-proof flame-resistant sheeting or tarpaulin.
- C. Handling:
  - 1. Material shall be handled in accordance with sound material handling practices and in such a way as to minimize racking.

#### 1.07 WARRANTY

- A. Special Warranty: Manufacturer and fabricator agree to repair or replace components of awnings that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:

- a. Structural failures including framework.
  - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- 2. Awning Warranty Period: One year from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

- A. The awnings and related materials herein specified and indicated on the drawings shall be as manufactured by: Construction Specialties, Inc. Melissa, TX. Awnings shall interface with the Centria Insulated Panel system
- B. Products equal to the Platform materials may be offered providing that the manufacturer and materials are pre-approved at least 10 working days before the bid date.

### **2.02 MATERIALS**

- A. Aluminum Extrusions: ASTM B211, Alloy 6063-T5, 6063-T6, 6005-T5, 6105-T5, 3003, 5005 or 6061-T6.
- B. Fasteners: Fasteners to be aluminum or stainless steel. Provide types, gauges and lengths to suit unit installation conditions.
- C. Anchors and Inserts: Use non-ferrous metal or hot dip galvanized anchors and inserts for installation and elsewhere as required for corrosion resistance. Use stainless steel or lead expansion bolt devices for drill in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

### **2.03 FABRICATION, GENERAL**

- A. Provide fixed awnings and accessories materials, sizes, depths, arrangements and material thickness to be as indicated or as required for optimal performance with respect to strength; durability; and uniform appearance.
- B. Include supports, anchorage, and accessories required for complete assembly.

### **2.04 AWNING MODELS**

- A. Platform MBS Awning System.
  - 1. Outriggers: 1/4" custom profile flat aluminum plate members, cut to match blade profile exactly.
  - 2. Fascia: 2" x 8" Tube
  - 3. Diagonal Support: 5/8" aluminum rod
  - 4. Mounting Bracket:

- a. Aluminum mounting bracket, by awning manufacturer. All fasteners mounting to structure to be designed and supplied by awning manufacturer. Fasteners to be stainless steel 300 Series.

## 2.05 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in C. appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Baked-Enamel Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  1. Color and Gloss: As selected by Architect from manufacturer's full range.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for supporting members, blocking, inserts, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. General: Install awnings at locations and in position indicated, securely connected to supports, free of rack, and in proper relation to adjacent construction. Use mounting methods of types described and in compliance with Shop Drawings and fabricator's written instructions.
- B. Install awnings after other finishing operations, including joint sealing and painting, have been completed.
- C. Slip fit frame connections accurately together to form hairline joints, and tighten to secure.
- D. Weld frame connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
  1. Field Welding: Comply with the following requirements:
    - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    - b. Obtain fusion without undercut or overlap.
    - c. Remove welding flux immediately.

- d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- E. Anchoring to In-Place Construction: Use anchors, fasteners, fittings, hardware, and installation accessories where necessary for securing awnings to structural support and for properly transferring load to in-place construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come in contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.
- G. Coordinate awning installation with flashing and joint-sealant installation so these materials are installed in sequence and in a manner that prevents exterior moisture from passing through completed exterior wall and roof assemblies.

### 3.03 CLEANING AND PROTECTION

- A. Touch up factory-applied finishes to restore damaged or soiled areas.
- B. Galvanized Surfaces: Clean field welds, connections, and abraded areas and repair galvanizing to comply with ASTM A780.

**END OF SECTION 10 73 13**

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**SECTION 11 30 13**  
**RESIDENTIAL APPLIANCES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Refrigeration appliances.

**1.02 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.
- C. Product Schedule: For appliances. Use same designations indicated on Drawings.

**1.04 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of appliance.
- C. Field quality-control reports.
- D. Sample Warranties: For manufacturers' special warranties.

**1.05 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

## 1.06 WARRANTY

- A. Special Warranties: Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Refrigerator/Freezer, Sealed System: Full warranty, including parts and labor, for on-site service on the product.
  - 1. Warranty Period for Sealed Refrigeration System: Two years from date of Substantial Completion.
  - 2. Warranty Period for Other Components: Two years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Source Limitations: Obtain each type of residential appliance from single manufacturer.

### 2.02 PERFORMANCE REQUIREMENTS

- A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 2.03 REFRIGERATOR/FREEZERS

- A. Refrigerator/Freezer: Two-door refrigerator/freezer with freezer on bottom and complying with AHAM HRF-1.
  - 1. Type: Freestanding.
  - 2. Dimensions:
    - a. Width: 16 inches.
    - b. Depth: 24 inches.
    - c. Height: 34-1/2 inches.
  - 3. Storage Capacity:
    - a. Refrigeration Compartment Volume: 15.6 cu. ft..
    - b. Freezer Volume: 5.13 cu. ft..
    - c. Shelf Area: Three adjustable glass shelves, 26 sq. ft..
  - 4. General Features:
    - a. Door Configuration: Framed.
    - b. Dispenser in door for cold water.
    - c. Dual refrigeration systems.
    - d. Separate temperature controls for each compartment.



5. Refrigerator Features:
  - a. Interior light in refrigeration compartment.
  - b. Compartment Storage: vegetable crisper and meat compartment.
  - c. Door Storage: Modular compartments.
  - d. Temperature-controlled meat/deli bin.
6. Freezer Features: One freezer compartment(s) with door(s).
  - a. Automatic defrost.
  - b. Interior light in freezer compartment.
  - c. Automatic icemaker and storage bin.
7. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product-labeling program.
8. Front Panel(s): Porcelain enamel.
  - a. Panel Color: White.
9. Appliance Color/Finish: White.

#### 2.04 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION

- A. Install appliances according to manufacturer's written instructions.

- B. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

### 3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections :
  - 1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
  - 2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After installation, start units to confirm proper operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
- B. An appliance will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

**END OF SECTION 11 30 13**

**SECTION 12 36 61.16****SOLID SURFACING COUNTERTOPS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Solid surface material countertops.
  - 2. Solid surface material backsplashes.
- B. Related Requirements:
  - 1. Section 22 42 16.16 "Commercial Sinks" for sinks.

**1.02 ACTION SUBMITTALS**

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
  - 1. Show locations and details of joints.
  - 2. Show direction of directional pattern, if any.
- C. Samples for Initial Selection: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
  - 1. Countertop material, 6 inches square.
  - 2. Wood trim, 8 inches long.
  - 3. One full-size solid surface material countertop, with front edge and backsplash, 8 by 10 inches, of construction and in configuration specified.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For fabricator.

**1.04 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

## 1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
  - 1. Build mockup of typical countertop as indicated on Drawings.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.06 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

## 1.07 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

# PART 2 - PRODUCTS

## 2.01 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ISFA 2-01.
  - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Corian by DuPont (basis of design)
    - b. Avonite by Aristech Surfaces, part of Trinseo
    - c. Wilsonart Solid Surface by Wilsonart.
  - 2. Type: Provide Standard type unless Special Purpose type is indicated.
  - 3. Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.
  - 4. Colors and Patterns: As indicated by manufacturer's designations.

## 2.02 FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
  - 1. Grade: Premium.
- B. Configuration:

1. Front: 3/4-inch bullnose.
2. Backsplash: Straight, slightly eased at corner.
3. End Splash: Matching backsplash.

C. Countertops:

1. 1/2-inch- thick, solid surface material with front edge built up with same material.

D. Backsplashes: 1/2-inch- thick, solid surface material.

E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.

F. Joints:

1. Fabricate countertops in sections for joining in field.
  - a. Joint Locations: Not within 18 inches of a sink and not where a countertop section less than 36 inches long would result, unless unavoidable.

G. Cutouts and Holes:

1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
  - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
2. Fittings: Drill countertops in shop for plumbing fittings, and similar items.

## 2.03 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 07 92 00 "Joint Sealants."

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- C. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- D. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
  - 1. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- F. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
  - 1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- H. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants."

**END OF SECTION 12 36 61.16**

## SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.01 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping :
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
    - b. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.

#### 3.02 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

**END OF SECTION 22 05 18**

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## SECTION 22 05 23.12 - BALL VALVES FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Bronze ball valves.
  - 2.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

#### 1.03 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, and soldered ends.
  - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

### PART 2 - PRODUCTS

#### 2.01 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

#### 2.02 PERFORMANCE REQUIREMENTS

- A. Standards:
  - 1. Domestic water valves intended to convey or dispense water for human consumption must comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
  2. ASME B16.18 for cast copper solder-joint connections.
  3. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
  4. ASME B31.9 for building services piping valves.
- C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.

## 2.03 BRONZE BALL VALVES

- A. Bronze Ball Valves, Two Piece with Regular Port and Bronze or Brass Trim, Threaded Ends:
1. Standard: MSS SP-110; MSS SP-145.
  2. CWP Rating: 600 psig.
  3. Body Design: Two piece.
  4. Body Material: Bronze.
  5. Ends: Threaded.
  6. Seats: PTFE.
  7. Stem: Bronze or brass.
  8. Ball: Chrome-plated brass.
  9. Port: Regular.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

### 3.02 INSTALLATION OF VALVES

- A. Provide support to piping adjacent to valves such that no force is imposed upon valves.
- B. Locate valves for easy access.
- C. For valves in horizontal piping, install valves with stem at or above center of pipe.

- D. Install valves in position to allow full valve actuation movement.
- E. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

### 3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

### 3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, provide the same types of valves with higher CWP ratings.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.

### 3.05 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  - 1. Bronze ball valves, two piece with regular port, and bronze or brass trim. Provide with threaded or solder -joint ends.

**END OF SECTION 22 05 23.12**

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## SECTION 22 05 23.14 - CHECK VALVES FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Bronze, swing check valves.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

#### 1.03 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, press connections, and weld ends.
  - 3. Set check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

### PART 2 - PRODUCTS

#### 2.01 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

#### 2.02 PERFORMANCE REQUIREMENTS

- A. Standards:
  - 1. Domestic water piping check valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372, or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
  2. ASME B16.18 for cast-copper solder joint.
  3. ASME B16.22 for wrought copper solder joint.
  4. ASME B31.9 for building services piping valves.
- C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.

### 2.03 BRONZE SWING CHECK VALVES

- A. Bronze, Swing Check Valves with Bronze Disc, Class 125:
1. Description:
    - a. Standard: MSS SP-80, Type 3.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Horizontal flow.
    - d. Body Material: ASTM B62, bronze.
    - e. Ends: Threaded or soldered. See valve schedule articles.
    - f. Disc: Bronze.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Do not attempt to repair defective valves; replace with new valves.

### 3.02 INSTALLATION OF VALVES

- A. Provide support of piping adjacent to valves such that no force is imposed upon valves.
- B. Locate valves for easy access and where not blocked by equipment, other piping, or building components.
- C. Install valves so that stems are horizontal or slope upward from centerline of pipe.
- D. Install valves in position that does not project into aisles or block access to other equipment.

- E. Install valves in position to allow full stem and manual operator movement.
- F. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.
- G. Check Valves: Install check valves for proper direction of flow.
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
- H. Adhere to manufacturer's installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

### 3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. End Connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered connections.

### 3.05 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  - 1. Bronze, swing check valves with bronze disc, Class 125, with soldered or threaded end connections.

**END OF SECTION 22 05 23.14**

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## SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Metal pipe hangers and supports.
  - 2. Trapeze pipe hangers.

### PART 2 - PRODUCTS

#### 2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
  - 3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
  - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

#### 2.02 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

#### 2.03 MATERIALS

- A. Carbon Steel: ASTM A1011/A1011M.

### PART 3 - EXECUTION

#### 3.01 APPLICATION

- A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

### 3.02 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping.
- F. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- H. Insulated Piping:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - 4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - 5. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

### 3.03 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.04 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use thermal hanger-shield inserts for insulated piping and tubing.
- G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
- H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
- I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
- J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
  - 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  - 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  - 4. C-Clamps (MSS Type 23): For structural shapes.
  - 5. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  2. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- L. S
- M. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

**END OF SECTION 22 05 29**

## SECTION 220533 - HEAT TRACING FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section includes heat tracing of plumbing piping for freeze prevention with self-regulating, parallel-resistance electric heating cables:

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
  - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample warranties.

#### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric heating cables and controls to include in operation and maintenance manuals.

#### 1.05 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
  - 1. Warranty Period: One year from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Source Limitations: Obtain all heat tracing from one manufacturer.
- B. Standard: IEEE 515.1.

- C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin.
- E. Grounding Cover: Tinned-copper braid.
- F. Cable Cover: Polyolefin outer jacket with ultraviolet inhibitor.
- G. Terminate cable with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.
- H. Maximum Operating Temperature (Power On): 150 deg F.
- I. Maximum Exposure Temperature (Power Off): 185 deg F.
- J. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a qualified testing agency, and marked for intended location and application.
- K. Capacities and Characteristics:
  - 1. Maximum Heat Output: 3 W/ft..
  - 2. Electrical Characteristics for Single-Circuit Connection:
    - a. Volts: 120 V.
    - b. Phase: 1Insert value.
    - c. Hertz: 60Insert number Hz.
    - d. Maximum Overcurrent Protection: 15Insert number A.

## 2.02 CONTROLS

- A. Control Panel:
  - 1. Microprocessor-based control with manual on, automatic, and standby/reset switch.
  - 2. Remote temperature sensor senses outside air temperature; programmable to energize the freeze-protection cable when temperature falls below 34 to 44 deg F.
  - 3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and temperature sensors.
  - 4. Minimum 30 A contactor to energize cable or close other contactors.
  - 5. Ground-fault protection.
  - 6. Single-point control of heat tracing for freeze protection.

## 2.03 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
  - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install electric heating cable at locations indicated and in accordance with NFPA 70.
- B. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- C. Install electric heating cables after piping has been tested and before insulation is installed.
- D. Install electric heating cables in accordance with IEEE 515.1.
- E. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install temperature-control units in an accessible location and in accordance with manufacturer's written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.
- G. Install control panels and distribution panels where indicated and in accordance with manufacturer's written instructions.

### **3.03 ELECTRICAL CONNECTIONS**

- A. Connect temperature-control unit for freeze protection to interrupt power supply to electric heating cable when outside air is above set point.
- B. Connect remote electronic temperature sensors.

### **3.04 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections :
  - 1. Perform tests after cable installation but before application of coverings, such as insulation, wall or ceiling construction, or concrete.
  - 2. Test cables for electrical continuity and insulation integrity before energizing.

- 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
  - C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
  - D. Cables will be considered defective if they do not pass tests and inspections.
  - E. Prepare test and inspection reports.
- 3.05 PROTECTION
- A. Protect installed heating cables, including nonheating leads, from damage.
  - B. Remove and replace damaged heat-tracing cables.

**END OF SECTION 220533**



## SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Pipe labels.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

### PART 2 - PRODUCTS

#### 2.01 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
  - 1. Pipe size.
  - 2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
  - 3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

### PART 3 - EXECUTION

#### 3.01 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

### 3.02 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Locate identifying devices so that they are readily visible from the point of normal approach.

### 3.03 INSTALLATION OF PIPE LABELS

- A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Within 3 ft. of each valve and control device.
  - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 3. Within 3 ft. of equipment items and other points of origination and termination.
  - 4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.
- C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- D. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe-Label Color Schedule:
  - 1. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
  - 2. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
  - 3. Sanitary Waste Piping: White letters on a black background.

**END OF SECTION 22 05 53**

## SECTION 22 07 19 - PLUMBING PIPING INSULATION

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section includes insulating the following plumbing piping services:
  - 1. Domestic cold-water piping.
  - 2. Domestic hot-water piping.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size, as well as ASTM standard designation and maximum use temperature.

## 1.06 COORDINATION

- A. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
  - 1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

### 2.02 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.
- B. Products do not contain asbestos, lead, mercury, or mercury compounds.
- C. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.
  - 1. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ-SSL.
  - 2. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
  - 3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

### 2.03 INSULATING CEMENTS

- A. Glass-Fiber and Mineral Wool Insulating Cement: Comply with ASTM C195.

### 2.04 ADHESIVES

- A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

### 2.05 SEALANTS

- A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Permanently flexible, elastomeric sealant.
2. Service Temperature Range: Minus 58 to plus 176 deg F.
3. Color: White or gray.

C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: White.

## 2.06 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

## 2.07 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

## 2.08 SECUREMENTS

A. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

# PART 3 - EXECUTION

## 3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

### 3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
  - 1.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
  2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- O. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
  2. Testing agency labels and stamps.
  3. Nameplates and data plates.
  4. Cleanouts.

### 3.04 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.

### 3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered or routed fittings made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly

against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

### 3.06 INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

#### B. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

#### C. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

### 3.07 FIELD QUALITY CONTROL

- A. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Resident Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of threaded fittings, three locations of threaded valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- B. All insulation applications will be considered defective if they do not pass tests and inspections.



- C. Prepare test and inspection reports.

### 3.08 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Underground piping.
  - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.09 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
  - 1. NPS 1 and Smaller: Insulation is the following:
    - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
  - 2. and Larger: Insulation is the following:
    - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Domestic Hot and Recirculated Hot Water:
  - 1. NPS 1-1/4 and Smaller: Insulation is the following:
    - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
  - 2. NPS 1-1/2 and Larger: Insulation is the following:
    - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
  - 1. All Pipe Sizes: Insulation is the following:
    - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- D.

**END OF SECTION 22 07 19**

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**SECTION 22 08 00****COMMISSIONING OF PLUMBING****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes Cx process requirements for the following plumbing systems, assemblies, and equipment:
  - 1. Domestic hot- and cold-water piping.
  - 2. Sanitary waste and vent piping.
  - 3. Plumbing equipment.
- B. Related Requirements:
  - 1. Section 01 91 13 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
  - 2. For construction checklists, comply with requirements in various Division 22 Sections specifying plumbing systems, system components, equipment, and products.

**1.02 DEFINITIONS**

- A. Cx: Commissioning, as defined in Section 01 91 13 "General Commissioning Requirements."
- B. CxA: Commissioning Authority, as defined in Section 01 91 13 "General Commissioning Requirements."
- C. IAPMO: International Association of Plumbing and Mechanical Officials.
- D. IgCC: International Green Construction Code.
- E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For plumbing testing technician.
- B. Construction Checklists:
  - 1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 01 91 13 "General Commissioning Requirements." Contractor is to review Construction Checklist in accordance with requirements in Section 01 91 13 "General Commissioning Requirements" and ASHRAE 202 and to resolve any issues with the CxA.
  - 2. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to plumbing to be part of the

Cx process and in accordance with requirements in Section 01 91 13 "General Commissioning Requirements", and ASHRAE 202.

- C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Contractor, provide the following:
1. Equipment/instrument identification number.
  2. Planned Cx application or use.
  3. Manufacturer, make, model, and serial number.
  4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
  5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:
    - a. Instrument or tool identification number.
    - b. Equipment schedule designation of equipment for which the instrument or tool is required.
    - c. Manufacturer, make, model, and serial number.
    - d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

#### 1.04 QUALITY ASSURANCE

- A. Plumbing Testing Technician Qualifications: Technicians to perform plumbing Construction Checklist verification tests. Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:
1. Journey level or equivalent skill level with knowledge of plumbing system, electrical concepts, and building operations.
  2. Minimum **three years'** experience installing, servicing, and operating systems manufactured by approved manufacturer.
- B. Testing Equipment and Instrumentation Quality and Calibration:
1. Capable of testing and measuring performance within the specified acceptance criteria.
  2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
  3. Be maintained in good repair and operating condition throughout duration of use on Project.
  4. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- C. Proprietary Test Instrumentation and Tools:
1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:
    - a. Be calibrated by manufacturer with current calibration tags permanently affixed.
    - b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
    - c. Plumbing system proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.01 CX PROCESS

- A. Perform Cx process for plumbing systems in accordance with:
  - 1. **ASHRAE 202.**
  - 2. **Commissioning standards acceptable to the authority having jurisdiction.**

### 3.02 CONSTRUCTION CHECKLISTS

- A. Preliminary detailed construction checklists are to be prepared under Section 01 91 13 "General Commissioning Requirements" for each plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in **ASHRAE 202**. Contractor performs the following:
  - 1. Review plumbing preliminary construction checklists and provide written comments on Construction Checklist items where appropriate.
  - 2. Return preliminary Construction Checklist with review comments within **10** days of receipt.
  - 3. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
  - 4. Use only construction checklists marked "Approved for Use, (date)." Mark construction checklists in the appropriate place, as indicated Project events are completed, and provide pertinent details and other information.
- B. Prepare preliminary detailed construction checklists for each plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in **ASHRAE 202**
  - 1. Submit preliminary construction checklists to CxA and Designer for review.
  - 2. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
  - 3. Use only construction checklists marked "Approved for Use, (date)." Mark construction checklists in the appropriate place as indicated Project events are completed, and provide pertinent details and other information.
- C. Systems Required to Be Commissioned:
  - 1. Domestic hot-water systems and controls.
- D. Additional Systems Required to Be Commissioned:
  - 1. Domestic water piping, including the following:
    - a. Domestic cold- and hot-water piping, fittings, and specialties inside the building.
    - b. Pumps, motors, accessories, and controls.
    - c. Sleeves and sleeve seals.
    - d. General-duty and specialty valves.
    - e. Hangers and supports.
  - 2. Sanitary waste and vent piping, including the following:

- a. Gravity and forced-main sewerage piping, fittings, and specialties.
- b. Drains.
- c. Sleeves and sleeve seals.
- d. General-duty and specialty valves.
- e. Hangers and supports.

3. Plumbing fixtures, including the following:

- a. Water closets, supports and connections, supplies, and flush valves.
- b. Urinals, supports and connections, supplies, and flush valves.
- c. Lavatories, supports, supplies, drain connections, and faucets.
- d. Sinks, supports, supplies, drain connections, and faucets.

### 3.03 CX TESTING PREPARATION

- A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.
- B. Certify that plumbing system instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and that all systems are set to and maintaining set points as required by the design documents.
- C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

### 3.04 CX TEST CONDITIONS

- A. Perform tests using design conditions, whenever possible.
  - 1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
  - 2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
  - 3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
- B. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.
- C. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

### 3.05 CX TESTS COMMON TO PLUMBING SYSTEMS

- A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.
- B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response compared to acceptance criteria.
- C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.
- D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 22 Sections specifying plumbing systems and equipment.
- E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:
  - 1. Cx Construction Checklist verification tests.
  - 2. Cx Construction Checklist verification test demonstrations.

**END OF SECTION**

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## SECTION 22 11 16 - DOMESTIC WATER PIPING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Copper tube and fittings.
  - 2. Piping joining materials.
  - 3. Transition fittings.
  - 4. Dielectric fittings.

#### 1.02 ACTION SUBMITTALS

- A. Product Data:
  - 1. Pipe and tube.
  - 2. Fittings.
  - 3. Joining materials.
  - 4. Transition fittings.

#### 1.03 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

### PART 2 - PRODUCTS

#### 2.01 PIPING MATERIALS

- A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

#### 2.02 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L.
- B. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- C. Wrought Copper Unions: ASME B16.22.

#### 2.03 PIPING JOINING MATERIALS

- A. Solder Filler Metals: ASTM B32, lead-free alloys.

- B. Flux: ASTM B813, water flushable.

#### 2.04 TRANSITION FITTINGS

- A. General Requirements:
  - 1. Same size as pipes to be joined.
  - 2. Pressure rating at least equal to pipes to be joined.
  - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

#### 2.05 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  - 1. Standard: ASSE 1079.
  - 2. Pressure Rating: 125 psig minimum at 180 deg F.
  - 3. End Connections: Solder-joint copper alloy and threaded ferrous.

### PART 3 - EXECUTION

#### 3.01 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
  - 1. Drawn-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

#### 3.02 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install domestic water piping level without pitch and plumb.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- E. Install piping to permit valve servicing.
- F. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.

### 3.03 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
- E. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

### 3.04 INSTALLATION OF TRANSITION FITTINGS

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.

### 3.05 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings.

### 3.06 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for hangers, supports, and anchor devices in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Install hangers for copper piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of copper piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.07 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

### 3.08 ADJUSTING

- A. Perform the following adjustments before operation:
  - 1. Open shutoff valves to fully open position.
  - 2. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
  - 3. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.09 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Piping Inspections:
    - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    - b. During installation, notify Resident Engineer at least one day before inspection must be made. Perform tests specified below in presence of Resident Engineer:
      - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
    - c. Reinspection: If Resident Engineer find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    - d. Reports: Prepare inspection reports and have them signed by Resident Engineer.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
  - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - b. Fill and isolate system according to either of the following:
    - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
    - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
  - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Repeat procedures if biological examination shows contamination.
  - e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

**END OF SECTION 22 11 16**

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## SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Vacuum breakers.
  - 2. Hose bibbs.
  - 3. Post hydrants.
  - 4. Water-hammer arresters.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Test and inspection reports.
- B. Field quality-control reports.

#### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

#### 2.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

## 2.03 VACUUM BREAKERS

### A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.

### B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.

## 2.04 HOSE BIBBS

### A. Hose Bibbs Insert drawing designation if any:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Operation for Service Areas: Wheel handle.

## 2.05 POST HYDRANTS

### A. Nonfreeze, Draining-Type Post Hydrants Insert drawing designation if any:

1. Standard: ASME A112.21.3M.
2. Type: Nonfreeze, exposed-outlet post hydrant.
3. Operation: Loose key.
4. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
5. Casing: Bronze with casing guard.
6. Inlet: NPS 3/4.
7. Outlet: Garden-hose thread complying with ASME B1.20.7.
8. Drain: Designed with hole to drain into ground when shut off.
9. Vacuum Breaker:
  - a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
  - b. Garden-hose thread complying with ASME B1.20.7 on outlet.
10. Operating Key(s): Two with each loose-key-operation wall hydrant.



## 2.06 WATER-HAMMER ARRESTERS

### A. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

## PART 3 - EXECUTION

### 3.01 INSTALLATION OF PIPING SPECIALTIES

- A. Nonfreeze, Draining-Type Post Hydrants: Install with 1 cu. yd. of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cu. ft. of concrete block at grade.
- B. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

### 3.02 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

### 3.03 ADJUSTING

### 3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections.
  1. Test each pressure vacuum breaker according to the device's reference standard.
  2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

**END OF SECTION 22 11 19**

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## **SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING**

### **PART 1 - GENERAL**

#### **1.01 SUMMARY**

- A. Section Includes:
  - 1. Hubless, cast-iron soil pipe and fittings.

#### **1.02 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

#### **1.03 WARRANTY**

- A. Listed manufacturers to provide labeling and warranty of their respective products.

### **PART 2 - PRODUCTS**

#### **2.01 PERFORMANCE REQUIREMENTS**

- A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10 ft. head of water.

#### **2.02 PIPING MATERIALS**

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

#### **2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS**

- A. Pipe and Fittings:
  - 1. Marked with CISPI collective trademark.
  - 2. ASTM A888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
  - 1. Standards: ASTM C1277 and CISPI 310.

2. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

## 2.04 SPECIALTY PIPE FITTINGS

### A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
  - a. Standard: ASTM C1173.
  - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - c. End Connections: Same size as and compatible with pipes to be joined.
  - d. Sleeve Materials:
    - 1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
    - 2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
    - 3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

### B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
  - a. Description:
    - 1) Standard: ASSE 1079.
    - 2) Pressure Rating: 125 psig minimum at 180 deg F.
    - 3) End Connections: Solder-joint copper alloy and threaded ferrous.

## PART 3 - EXECUTION

### 3.01 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
  2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- C. Install piping at indicated slopes.

- D. Install piping free of sags and bends.
- E. Install fittings for changes in direction and branch connections.
- F. Install piping to allow application of insulation.
- G. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
  - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
  - 2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
    - a. Straight tees, elbows, and crosses may be used on vent lines.
  - 3. Do not change direction of flow more than 90 degrees.
  - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of waste piping in direction of flow is prohibited.
- H. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
  - 1. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow.
  - 2. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.
- I. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

### 3.02 JOINT CONSTRUCTION

- A. ked joints.
- B. Hubless, Cast-Iron Soil Piping Coupled Joints:
  - 1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

### 3.03 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
  - 1. Install transition couplings at joints of piping with small differences in ODs.
  - 2. In Waste Drainage Piping: Unshielded, nonpressure transition couplings.
  - 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
  - 4. In Underground Force Main Piping:
    - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
    - b. NPS 2 and Larger: Pressure transition couplings.
- B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

### 3.04 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hanger and support devices and installation specified in.
  1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
  2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
  3. Vertical Piping: MSS Type 8 or Type 42 clamps.
  4. Install individual, straight, horizontal piping runs:
    - a. 100 Ft. and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Ft.: MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Ft. if Indicated: MSS Type 49, spring cushion rolls.
  5. Multiple, Straight, Horizontal Piping Runs 100 Ft. or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
  6. Base of Vertical Piping: MSS Type 52 spring hangers.
- B. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical runs of cast-iron soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.05 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
  1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
  2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
  3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.

### 3.06 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.

### 3.07 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - 2. Final Inspection: Arrange for final inspection by Resident Engineer to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If Resident Engineer find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by Resident Engineer.
- D. Test sanitary waste and vent piping as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
    - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.
  - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
    - a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
    - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    - c. Inspect joints for leaks.
  - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
    - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg.
    - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    - d. Inspect plumbing fixture connections for gas and water leaks.
  - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  - 6. Prepare reports for tests and required corrective action.

### 3.08 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.

- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Repair damage to adjacent materials caused by waste and vent piping installation.

### 3.09 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller are to be the following:
  - 1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
- C. Aboveground, vent piping NPS 4 and smaller is to be the following:
  - 1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

**END OF SECTION 22 13 16**



## SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Cleanouts.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.01 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

#### 2.02 CLEANOUTS

- A. Cast-Iron Exposed Cleanouts:
  - 1. Standard: ASME A112.36.2M.
  - 2. Size: Same as connected drainage piping
  - 3. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
  - 4. Closure: Countersunk, cast-iron plug.
  - 5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Cast-Iron Wall Cleanouts Insert drawing designation, if any:
  - 1. Standard: ASME A112.36.2M. Include wall access.

2. Size: Same as connected drainage piping.
3. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure Plug:
  - a. Cast iron.
  - b. Countersunk head.
  - c. Drilled and threaded for cover attachment screw.
  - d. Size: Same as or not more than one size smaller than cleanout size.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION**

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  2. Locate at each change in direction of piping greater than 45 degrees.
  3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  4. Locate at base of each vertical soil and waste stack.

#### **3.02 PIPING CONNECTIONS**

- A. Install piping adjacent to equipment, to allow service and maintenance.

#### **3.03 PROTECTION**

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 13 19**

## SECTION 22 13 19.13 - SANITARY DRAINS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Floor drains.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.01 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

#### 2.02 FLOOR DRAINS

- A. Cast-Iron Floor Drains Insert drawing designation if any:
  - 1. Standard: ASME A112.6.3.
  - 2. Pattern: Floor drain.
  - 3. Body Material: Gray iron.
  - 4. Seepage Flange: Not required.
  - 5. Anchor Flange: Not required.
  - 6. Clamping Device: Required.
  - 7. Outlet: Bottom.
  - 8. Top or Strainer Material: Bronze.
  - 9. Top Shape: Round.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  - 1. Position floor drains for easy access and maintenance.
  - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.

3. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.02 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 13 19.13**

## SECTION 22 33 00 - ELECTRIC, DOMESTIC-WATER HEATERS

### PART 1 - GENERAL

#### 1.01 SUMMARY

##### A. Section Includes:

1. Commercial, electric, storage, domestic-water heaters.
2. Flow-control, electric, tankless, domestic-water heaters.

#### 1.02 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of commercial and tankless, electric, domestic-water heater.
- B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

#### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

#### 1.05 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

#### 1.06 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Structural failures including storage tank and supports.
  - b. Faulty operation of controls.
  - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Periods: From date of Substantial Completion.
- a. Commercial, Electric, Storage, Domestic-Water Heaters:
    - 1) Storage Tank: Three years.
    - 2) Controls and Other Components: Three years.
  - b. Electric, Tankless, Domestic-Water Heaters: Five year(s).

## **PART 2 - PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

### **2.02 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS**

- A. Commercial, Electric, Storage, Domestic-Water Heaters:
  - 1. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
  - 2. Standard: UL 1453.
  - 3. Storage-Tank Construction: ASME-code, steel vertical arrangement.
    - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      - 1) NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.
    - b. Pressure Rating: 150 psig.
    - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
  - 4. Factory-Installed, Storage-Tank Appurtenances:
    - a. Anode Rod: Replaceable magnesium.
    - b. Drain Valve: Corrosion-resistant metal with hose-end connection.

- c. Insulation: Comply with ASHRAE/IES 90.1.
- d. Jacket: Steel with enameled finish or high-impact composite material.
- e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
- f. Temperature Control: Adjustable thermostat.
- g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
- h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

## 2.03 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

### A. Flow-Control, Electric, Tankless, Domestic-Water Heaters:

- 1. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
- 2. Standard: UL 499 for electric, tankless, (domestic-water-heater) heating appliance.
- 3. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.
  - a. Connections: ASME B1.20.1 pipe thread.
  - b. Pressure Rating: 150 psig.
  - c. Heating Element: Resistance heating system.
  - d. Temperature Control: Flow-control fitting.
  - e. Safety Control: High-temperature-limit cutoff device or system.
  - f. Jacket: Aluminum or steel with enameled finish or plastic.
- 4. Support: Bracket for wall mounting.

## 2.04 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.01 DOMESTIC-WATER HEATER INSTALLATION

#### A. Commercial, Electric, Domestic-Water Heater Mounting:

- 1. Maintain manufacturer's recommended clearances.

2. Arrange units so controls and devices that require servicing are accessible.
- B. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
1. Maintain manufacturer's recommended clearances.
  2. Arrange units so controls and devices that require servicing are accessible.
  3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Install anchor bolts to elevations required for proper attachment to supported equipment.
  5. Anchor domestic-water heaters to substrate.
- C. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.
- D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Fill electric, domestic-water heaters with water.
- F. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.
- 3.02 FIELD QUALITY CONTROL
- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

**END OF SECTION 22 33 00**



## SECTION 22 42 13.13 - COMMERCIAL WATER CLOSETS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Wall-mounted water closets.
  - 2. Flushometer valves.
  - 3. Toilet seats.
  - 4. Supports.

#### 1.02 ACTION SUBMITTALS

- A. Product Data:
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

#### 1.03 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Standards:
  - 1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
  - 2. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
  - 3. Comply with ICC A117.1 for ADA-compliant water closets.

#### 2.02 WALL-MOUNTED WATER CLOSETS

- A. Water Closets - Wall Mounted, Top Spud: Insert drawing designation.
  - 1. Source Limitations: Obtain water closets from single source from single manufacturer.
  - 2. Bowl:
    - a. Material: Vitreous china.
    - b. Type: Siphon jet.

- c. Style: Flushometer valve.
- d. Mounting Height: ADA compliant.
- e. Rim Contour: Elongated.
- f. Water Consumption: 1.6 gal. per flush.
- g. Spud Size and Location: NPS 1-1/2; top.
- h. Color: White.

- 3. Support: Water-closet carrier.

## 2.03 FLUSHOMETER VALVES

### A. Flushometer Valves - Diaphragm, Lever Handle: Insert designation.

- 1. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
- 2. Minimum Pressure Rating: 125 psig.
- 3. Features: Include integral check stop and backflow-prevention device.
- 4. Material: Brass body with corrosion-resistant components.
- 5. Style: Exposed.
- 6. Flushometer-Valve Finish: Chrome-plated.
- 7. Handle Finish: Chrome-plated.
- 8. Consumption: 1.6 gal. per flush.
- 9. Minimum Inlet: NPS 1.
- 10. Minimum Outlet: NPS 1-1/4.

## 2.04 TOILET SEATS

### A. Toilet Seats:

- 1. Source Limitations: Obtain toilet seat from single source from single manufacturer.
- 2. Material: Plastic.
- 3. Type: Commercial (Heavy duty).
- 4. Shape: Elongated rim, open front.
- 5. Hinge: Check.
- 6. Hinge Material: Noncorroding metal.
- 7. Seat Cover: Not required.
- 8. Color: White.
- 9. Surface Treatment: Antimicrobial.

## 2.05 SUPPORTS

### A. Water-Closet Carrier:

- 1. Source Limitations: Obtain water-closet carrier from single source from single manufacturer.
- 2. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION, GENERAL**

- A. Water-Closet Installation:
  - 1. Install level and plumb.
  - 2. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.
- B. Support Installation:
  - 1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
  - 2. Use carrier supports with waste-fitting assembly and seal.
  - 3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
  - 4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
  - 5. Measure support height installation from finished floor, not structural floor.
- C. Flushometer-Valve Installation:
  - 1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
  - 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
  - 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
  - 4. Install actuators in locations easily reachable for people with disabilities.
- D. Install toilet seats on water closets.
- E. Joint Sealing:
  - 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
  - 2. Match sealant color to water-closet color.
  - 3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

### **3.03 PIPING CONNECTIONS**

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

**3.04 ADJUSTING**

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

**3.05 CLEANING AND PROTECTION**

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 42 13.13**

## SECTION 22 42 16.13 - COMMERCIAL LAVATORIES

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Vitreous-china, wall-mounted lavatories.
  - 2. Manually operated lavatory faucets.
  - 3. Supply fittings.
  - 4. Waste fittings.
  - 5. Lavatory supports.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

#### 1.03 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.01 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory - Rectangular, Vitreous China, Wall Mounted, with Back Insert drawing designation:
  - 1. Fixture:
    - a. Standard: ASME A112.19.2/CSA B45.1.
    - b. Type: For wall hanging.
    - c. Faucet-Hole Punching: Three holes, 4-inch centers.
    - d. Faucet-Hole Location: Top.
    - e. Color: White.
    - f. Mounting Material: Chair carrier.
  - 2. Lavatory Mounting Height: Handicapped/elderly in accordance with ICC A117.1.

## 2.02 MANUALLY OPERATED LAVATORY FAUCETS

- A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI) accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Lavatory Faucets - Manual Type: Two-Handle Mixing, Commercial:
  - 1. Standard: ASME A112.18.1/CSA B125.1.
  - 2. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
  - 3. Body Type: Centerset.
  - 4. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
  - 5. Finish: Polished chrome plate.
  - 6. Maximum Flow Rate: 0.5 gpm.
  - 7. Mounting Type: Deck, exposed.
  - 8. Valve Handle(s): Wrist blade, 4 inches.
  - 9. Spout: Rigid type.
  - 10. Spout Outlet: Aerator.
  - 11. Operation: Compression, manual.
  - 12. Drain: Not part of faucet.

## 2.03 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.

## 2.04 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
  - 1. Size: NPS 1-1/4.
  - 2. Material:
    - a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated, brass or steel wall flange.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install lavatories level and plumb in accordance with roughing-in drawings.
- B. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.
- C. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- D. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- E. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

### **3.03 PIPING CONNECTIONS**

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

### **3.04 ADJUSTING**

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

### **3.05 CLEANING AND PROTECTION**

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 16.13



## SECTION 22 42 16.16 - COMMERCIAL SINKS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Service sinks.
  - 2. Kitchen/utility sinks.
  - 3. Manually operated sink faucets.
  - 4. Supply fittings.
  - 5. Waste fittings.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
  - 2. Include rated capacities, operating characteristics and furnished specialties and accessories.

#### 1.03 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sinks and faucets to include in operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.01 SERVICE SINKS

- A. Service Sinks - Enameled Cast Iron, Trap Standard Mounted:
  - 1. Source Limitations: Obtain sinks from single source from single manufacturer.
  - 2. Fixture:
    - a. Standard: ASME A112.19.1/CSA B45.2.
    - b. Type: Service sink with back.
    - c. Back: Two faucet holes.
    - d. Color: White.
    - e. Mounting: NPS 3 P-trap standard with grid strainer inlet, cleanout, and floor flange.
    - f. Rim Guard: On front and sides.

#### 2.02 KITCHEN/UTILITY SINKS

- A. Kitchen/Utility Sinks - Stainless Steel, Counter Mounted:

1. Source Limitations: Obtain sinks from single source from single manufacturer.
2. Fixture:
  - a. Standard: ASME A112.19.3/CSA B45.4.
  - b. Type: Stainless steel, self-rimming, sound-deadened unit less ledge back.
  - c. Number of Compartments: One.
  - d. Material: 18 gauge, Type 304 stainless steel.
  - e. Compartment:
    - 1) Drain Location: Centered in compartment.
    - 2) Depth: Standard.
3. Faucet(s):
  - a. Number Required: One.
4. Supply Fittings:
  - a. Standard: ASME A112.18.1/CSA B125.1.
  - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
    - 1) Operation: Wheel handle.
    - 2) Risers: NPS 1/2, ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.
5. Waste Fittings:
  - a. Standard: ASME A112.18.2/CSA B125.2.
  - b. Trap(s):
    - 1) Size: NPS 1-1/2.
    - 2) Material:
      - a) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

## 2.03 MANUALLY OPERATED SINK FAUCETS

- A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Commercial Sink Faucets - Manual Type: Single-control mixing, Insert type Insert designation.
  1. Source Limitations: Obtain sink faucets from single source from single manufacturer.
  2. Standard: ASME A112.18.1/CSA B125.1.
  3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
  4. Body Type: Centerset.
  5. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.

6. Finish: Chrome plated.
7. Mounting Type: Deck, exposed.
8. Valve Handle(s): Lever.
9. Spout Type: Swing.
10. Vacuum Breaker: Not required for hose outlet.
11. Spout Outlet: Aerator.

C. Commercial Service Sink Faucets - Manual Type:.

1. Source Limitations: Obtain sink faucets from single source from single manufacturer.
2. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inch hose thread end, integral vacuum breaker, inlets 8 inches o.c., and two-handle mixing.
3. Faucet:
  - a. Standards:
    - 1) ASME A112.18.1/CSA B125.1.
    - 2) NSF 61 and NSF 372.
    - 3) ICC A117.1.
    - 4) ASSE 1001 (VB).
  - b. Finish: Polished chrome plated.
  - c. Handles: Lever.
  - d. Cartridges: One-fourth turn compression.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install sinks level and plumb in accordance with rough-in drawings.
- B. Install wall-mounted sinks at accessible mounting height in accordance with ICC A117.1.
- C. Install water-supply piping with stop on each supply to each sink faucet.
  1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping"
  2. Install stops in locations where they can be easily reached for operation.

- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- E. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

### 3.03 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

### 3.04 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

### 3.05 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.

**END OF SECTION 22 42 16.16**

## SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### 1.02 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

### PART 2 - PRODUCTS

#### 2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

#### 2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

#### 2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.

- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

#### 2.04 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers:
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
  - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

#### 2.05 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.

- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION 23 05 13**

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## SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.01 SUMMARY

##### A. Section Includes:

1. Fastener systems.
- 2.
3. Equipment supports.

#### 1.02 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

- 1.

##### B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Equipment supports.

#### 1.03 INFORMATIONAL SUBMITTALS

##### A. Welding certificates.

#### 1.04 QUALITY ASSURANCE

##### A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

##### B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

#### 2.02 FASTENER SYSTEMS

- ##### A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Indoor Applications: Zinc-coated steel.
  - 2. Outdoor Applications: Stainless steel.

#### 2.03 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

#### 2.04 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.
- D. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

### PART 3 - EXECUTION

#### 3.01 APPLICATION

- A. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

#### 3.02 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Provide lateral bracing, to prevent swaying, for equipment supports.

#### 3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

**END OF SECTION 23 05 29**

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## SECTION 230533 - HEAT TRACING FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section includes heat tracing for freeze prevention of HVAC piping with self-regulating, parallel-resistance, electric heating cables:

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
  - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample warranties.

#### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric heating cables and controls to include in operation and maintenance manuals.

#### 1.05 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
  - 1. Warranty Period: One year from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Source Limitations: Obtain all heat tracing from one manufacturer.
- B. Standard: IEEE 515.1.

- C. Heating Element: Pair of parallel **No. 16 AWG, nickel-coated**, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin.
- E. Grounding Cover: **Tinned-copper** braid.
- F. Cable Cover: **and polyolefin outer jacket with ultraviolet inhibitor**.
- G. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.
- H. Maximum Operating Temperature (Power On): **150 deg F**.
- I. Maximum Exposure Temperature (Power Off): **185 deg F**.
- J. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- K. Capacities and Characteristics:
  - 1. Maximum Heat Output: **3 W/ft.**
  - 2. Electrical Characteristics for Single-Circuit Connection:
    - a. Volts: **120 V**.
    - b. Phase: **1**.
    - c. Hertz: **60 Hz**.
    - d. Maximum Overcurrent Protection: **15 A**.

## 2.02 CONTROLS

- A. Control Panel:
  - 1. **Microprocessor-based** control with manual on, automatic, and standby/reset switch.
  - 2. Remote temperature sensors sense outside air temperature; programmable to energize the cable when temperature falls below **34 to 44 deg F**.
  - 3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
  - 4. Minimum 30 A contactor to energize cable or close other contactors.
  - 5. Ground-fault protection.
  - 6. Single-point control of heat tracing for freeze protection.

## 2.03 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
  - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install electric heating cable at locations indicated and in accordance with NFPA 70.
- B. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- C. Install electric heating cables after piping has been tested and before insulation is installed.
- D. Install electric heating cables in accordance with IEEE 515.1.
- E. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install temperature-control units in an accessible location and in accordance with manufacturer's written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.
- G. Install control panels and distribution panels where indicated and in accordance with manufacturer's written instructions.

### **3.03 ELECTRICAL CONNECTIONS**

- A. Connect temperature-control unit to interrupt power supply to electric heating cable when outside air is above set point.
- B. Connect remote electronic temperature sensors.

### **3.04 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections :
  - 1. Perform tests after cable installation but before application of coverings, such as insulation, wall or ceiling construction, or concrete.
  - 2. Test cables for electrical continuity and insulation integrity before energizing.

- 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
  - C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
  - D. Cables will be considered defective if they do not pass tests and inspections.
  - E. Prepare test and inspection reports.
- 3.05 PROTECTION
- A. Protect installed heating cables, including nonheating leads, from damage.
  - B. Remove and replace damaged heat-tracing cables.

**END OF SECTION 230533**



**SECTION 23 05 48****VIBRATION AND SEISMIC CONTROLS FOR HVAC****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Elastomeric isolation pads
2. Elastomeric isolation mounts
3. Restrained elastomeric isolation mounts
4. Open-spring isolators
5. Housed-spring isolators
6. Restrained-spring isolators
7. Housed-restrained-spring isolators
8. Elastomeric hangers
9. Spring hangers
10. Snubbers
11. Restraints - rigid type
12. Restraints - cable type
13. Restraint accessories
- 14.

**1.02 ACTION SUBMITTALS****A. Product Data:** For each type of product.**B. Shop Drawings:**

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

**C. Delegated-Design Submittal:**

1. For each seismic-restraint and wind-load protection device, including seismic-restrained mounting, snubber, seismic restraint, seismic-restraint accessory, concrete anchor and insert, and restrained isolation roof-curb rail that is required by this Section or is indicated on Drawings, submit the following:
  - a. Seismic and Wind-Load Restraint, and Vibration Isolation Base Selection: Select vibration isolators, seismic and wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
  - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.

- c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
  - d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
  - e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
  - f. Qualified Professional Engineer: All designated-design submittals for seismic- and wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic- and Wind Restraint Detail Drawing:
- a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
  - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
  - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
3. All delegated-design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
4. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and basis for approval (tests or calculations).
5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Welding certificates.
- C. Field quality-control reports.
- D. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
  - 1. Provide equipment manufacturer's written certification for each designated active mechanical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction.

2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-16.
  3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
- E. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.
1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
  2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
  3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

#### 1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing or UL product listing or FM Approvals or an evaluation service member of ICC-ES an agency acceptable to authorities having jurisdiction.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Consequential Damage: Provide additional seismic restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-16 so that failure of a non-essential or essential HVAC component will not cause failure of any other essential architectural, mechanical, or electrical building component.
- B. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- C. Component Supports:
1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-16 Section 13.6.

## 2.02 ELASTOMERIC ISOLATION PADS

### A. Elastomeric Isolation Pads:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
4. Surface Pattern: Smooth, ribbed, or waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.
  - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
  - b. Infused nonwoven cotton or synthetic fibers.

## 2.03 ELASTOMERIC ISOLATION MOUNTS

### A. Double-Deflection, Elastomeric Isolation Mounts: .

1. Mounting Plates:
  - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.
  - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
2. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

## 2.04 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts.

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - a. Housing: Cast-ductile iron or welded steel.
  - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.05 OPEN-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

## 2.06 HOUSED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
  - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
  - b. Top housing with attachment and leveling bolt.

## 2.07 RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
  - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
  - b. Top plate with threaded mounting holes or elastomeric pad.
  - c. Internal leveling bolt that acts as blocking during installation.
2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.08 HOUSED-RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
  - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
  - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.09 ELASTOMERIC HANGERS

### A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods.

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.10 SPRING HANGERS

### A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.11 SNUBBERS

- ### A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2015 or 2018 IBC.
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

#### 2.12 RESTRAINTS - RIGID TYPE

- A. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

#### 2.13 RESTRAINTS - CABLE TYPE

- A. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- B. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

#### 2.14 RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## PART 3 - EXECUTION

### 3.01 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

### 3.02 INSTALLATION OF VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."
- D. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- E. Equipment Restraints:
  - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 3. Install seismic-restraint devices using methods approved by OSHPD or an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- F. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports a maximum of 40 feet o.c. and longitudinal supports a maximum of 80 feet o.c.
  - 3. Brace a change of direction longer than 12 feet.
- G. Install seismic restraint cables so they do not bend across edges of adjacent equipment or building structure.



- H. Install seismic-restraint devices using methods approved by OSHPD or an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- L. Mechanical Anchor Bolts:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.03 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7.

### 3.04 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

### 3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
  - 1. Perform tests and inspections.
  - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

3. Schedule test with Owner, through Architect, before connecting anchorage device to re-strained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
  4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  5. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
  6. Test to 90 percent of rated proof load of device.
  7. Measure isolator restraint clearance.
  8. Measure isolator deflection.
  9. Verify snubber minimum clearances.
  10. Test and adjust restrained-air-spring isolator controls and safeties.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Units will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

**END OF SECTION**

## SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.01 SUMMARY

##### A. Section Includes:

1. Equipment labels.

#### 1.02 ACTION SUBMITTALS

- ##### A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.01 EQUIPMENT LABELS

##### A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- ##### B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

### PART 3 - EXECUTION

#### 3.01 PREPARATION

- ##### A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.02 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

3.03 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of mechanical equipment.
- B. Sign and Label Colors:
  - 1. White letter on black background.
- C. Locate equipment labels where accessible and visible.

**END OF SECTION 23 05 53**

## SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Testing, Adjusting, and Balancing of Air Systems:
    - a. Constant-volume air systems.
  - 2. HVAC-control system verification.

#### 1.02 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.
- G. UFAD: Underfloor air distribution.

#### 1.03 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
  - 1. Minimum Agenda Items:
    - a. The Contract Documents examination report.
    - b. The TAB plan.
    - c. Needs for coordination and cooperation of trades and subcontractors.
    - d. Proposed procedures for documentation and communication flow.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

#### 1.05 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by NEBB or TABB:
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

### **PART 2 - PRODUCTS (Not Applicable)**

### **PART 3 - EXECUTION**

#### 3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data, including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
- J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.02 PREPARATION

- A. Prepare a TAB plan that includes the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Airside:
    - a. Duct systems are complete with terminals installed.
    - b. Volume, smoke, and fire dampers are open and functional.
    - c. Clean filters are installed.
    - d. Fans are operating, free of vibration, and rotating in correct direction.

- e. Variable-frequency controllers' startup is complete and safeties are verified.
- f. Ceilings are installed.
- g. Windows and doors are installed.
- h. Suitable access to balancing devices and equipment is provided.

### 3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. After testing and balancing, install test ports and duct access doors
  - 3. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
  - 4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.04 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

- A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
  - 1. Motors.
  - 2. Fans and ventilators.
  - 3. Condensing units.
  - 4. Air-handling units.
  - 5. Split-system air conditioners.

### 3.05 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' Record drawings duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.



- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.

### 3.06 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
  - 2. Measure fan static pressures as follows:
    - a. Measure static pressure directly at the fan outlet or through the flexible connection.
    - b. Measure static pressure directly at the fan inlet or through the flexible connection.
    - c. Measure static pressure across each component that makes up the air-handling system.
    - d. Report artificial loading of filters at the time static pressures are measured.
  - 3. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
  - 1. Measure airflow of submain and branch ducts.
  - 2. Adjust submain and branch duct volume dampers for specified airflow.
  - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
  - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
  - 2. Measure inlets and outlets airflow.
  - 3. Adjust each inlet and outlet for specified airflow.
  - 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

### 3.07 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.
- 9.

### 3.08 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

- A. Verify proper rotation of fan(s).
- B. Measure and record entering- and leaving-air temperatures.
- C. Measure and record entering and leaving refrigerant pressures.
- D. Measure and record operating data of compressor(s), fan(s), and motors.

### 3.09 HVAC CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
1. Verify HVAC control system is operating within the design limitations.
  2. Verify that controllers are calibrated and function as intended.
  3. Verify that controller set points are as indicated.
  4. Verify the operation of lockout or interlock systems.
  5. Verify the operation of valve and damper actuators.
  6. Verify that controlled devices are properly installed and connected to correct controller.
  7. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
  8. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

### 3.10 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
  - 2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

### 3.11 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - 2. Include a list of instruments used for procedures, along with proof of calibration.
  - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  - 1. Fan curves.
  - 2. Manufacturers' test data.
  - 3. Field test reports prepared by system and equipment installers.
  - 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
  - 1. Title page.
  - 2. Name and address of the TAB specialist.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB supervisor who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents, including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  - 12. Nomenclature sheets for each item of equipment.
  - 13. Notes to explain why certain final data in the body of reports vary from indicated values.
  - 14. Test conditions for fans performance forms, including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.

- b. Conditions of filters.
- c. Cooling coil, wet- and dry-bulb conditions.
- d. Heating coil, dry-bulb conditions.
- e. Face and bypass damper settings at coils.
- f. Fan drive settings, including settings and percentage of maximum pitch diameter.
- g. Variable-frequency controller settings for variable-air-volume systems.
- h. Settings for pressure controller(s).
- i. Other system operating conditions that affect performance.

D. Air-Handling-Unit Test Reports: For air-handling units, include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Unit arrangement and class.
- g. Discharge arrangement.
- h. Sheave make, size in inches, and bore.
- i. Center-to-center dimensions of sheave and amount of adjustments in inches.
- j. Number, make, and size of belts.
- k. Number, type, and size of filters.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and speed.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan speed.
- d. Inlet and discharge static pressure in inches wg.
- e. For each filter bank, filter static-pressure differential in inches wg.
- f. Cooling-coil static-pressure differential in inches wg.
- g. List for each internal component with pressure-drop, static-pressure differential in inches wg.
- h. Outdoor airflow in cfm.
- i. Return airflow in cfm.
- j. Outdoor-air damper position.
- k. Return-air damper position.
- l. .

E. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.

- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft..
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Refrigerant expansion valve and refrigerant types.
- i. Refrigerant suction pressure in psig.
- j. Refrigerant suction temperature in deg F.

F. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Coil identification.
- d. Capacity in Btu/h.
- e. Number of stages.
- f. Connected volts, phase, and hertz.
- g. Rated amperage.
- h. Airflow rate in cfm.
- i. Face area in sq. ft..
- j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

- a. Heat output in Btu/h.
- b. Airflow rate in cfm.
- c. Air velocity in fpm.
- d. Entering-air temperature in deg F.
- e. Leaving-air temperature in deg F.
- f. Voltage at each connection.
- g. Amperage for each phase.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.

- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches, and bore.
- h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and speed.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Center-to-center dimensions of sheave and amount of adjustments in inches.
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan speed.
- d. Discharge static pressure in inches wg.
- e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

- a. System fan and air-handling-unit number.
- b. Location and zone.
- c. Traverse air temperature in deg F.
- d. Duct static pressure in inches wg.
- e. Duct size in inches.
- f. Duct area in sq. ft..
- g. Indicated airflow rate in cfm.
- h. Indicated velocity in fpm.
- i. Actual airflow rate in cfm.
- j. Actual average velocity in fpm.
- k. Barometric pressure in psig.

I. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

### 3.12 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Resident Engineer.
- B. Resident Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.
- E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
  - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
  - 2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.
- F. Prepare test and inspection reports.

**END OF SECTION 23 05 93**

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**SECTION 23 08 00**  
**COMMISSIONING OF HVAC**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section includes Cx process requirements for the following HVAC systems, assemblies, and equipment:
  - 1. Cooling generation systems.
  - 2. Air-handling systems.
  - 3. Air distribution systems.
  - 4. Heating and cooling unitary equipment.
  - 5. HVAC controls.
  - 6. TAB verification.
- B. Related Requirements:
  - 1. Section 01 91 13 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
  - 2. For construction checklists, comply with requirements in various Division 23 Sections specifying HVAC systems, system components, equipment, and products.

**1.02 DEFINITIONS**

- A. BAS: Building automation system.
- B. Cx: Commissioning, as defined in Section 01 91 13 "General Commissioning Requirements."
- C. CxA: Commissioning Authority, as defined in Section 01 91 13 "General Commissioning Requirements."
- D. IgCC: International Green Construction Code.
- E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they mean "as-built" systems, assemblies, subsystems, equipment, and components.
- F. TAB: Testing, adjusting, and balancing.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For **HVAC** testing technician.
- B. Construction Checklists:

1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 01 91 13 "General Commissioning Requirements." Div. 23 Subcontractor is to review Construction Checklist in accordance with requirements in Section 01 91 13 "General Commissioning Requirements" and ASHRAE 202 and to resolve any issues with the CxA.
  2. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to **HVAC** to be part of the Cx process and in accordance with requirements in Section 01 91 13 "General Commissioning Requirements and ASHRAE 202."
- C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Div. 23 Subcontractor, provide the following:
1. Equipment/instrument identification number.
  2. Planned Cx application or use.
  3. Manufacturer, make, model, and serial number.
  4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
  5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:
    - a. Instrument or tool identification number.
    - b. Equipment schedule designation of equipment for which the instrument or tool is required.
    - c. Manufacturer, make, model, and serial number.
    - d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

#### 1.04 QUALITY ASSURANCE

- A. HVAC Testing Technician Qualifications: Technicians to perform HVAC Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:
1. Journey level or equivalent skill level; vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.
  2. Minimum **three years'** experience that is to include installing, servicing, and operating systems manufactured by approved manufacturer.
- B. Testing Equipment and Instrumentation Quality and Calibration:
1. Capable of testing and measuring performance within the specified acceptance criteria.
  2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
  3. Be maintained in good repair and operating condition throughout duration of use on Project.
  4. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- C. Proprietary Test Instrumentation and Tools:
1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by

equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

- a. Be calibrated by manufacturer with current calibration tags permanently affixed.
  - b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
2. HVAC proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

## **PART 2 - PRODUCTS (Not Used)**

## **PART 3 - EXECUTION**

### **3.01 CX PROCESS:**

- A. Perform Cx process in accordance with Section 01 91 13 "General Commissioning Requirements" for **HVAC** and in accordance with the following:
1. **ASHRAE 202.**
  2. **Commissioning standards acceptable to the authority having jurisdiction.**

### **3.02 CONSTRUCTION CHECKLISTS**

- A. Preliminary detailed construction checklists are to be prepared under Section 01 91 13 "General Commissioning Requirements" for each **HVAC** system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in **ASHRAE 202**. Contractor performs the following:
1. Review **HVAC** preliminary construction checklists and provide written comments on checklist items where appropriate.
  2. Return preliminary Construction Checklist with review comments within **10 >** days of receipt.
  3. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
  4. Use only construction checklists marked "Approved for Use, (date)" When performing tests. Mark construction checklists in the appropriate place as indicated Project events are completed, and provide pertinent details and other information.
- B. Prepare preliminary detailed construction checklists for each **HVAC** system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in **ASHRAE 202**.
1. Submit preliminary construction checklists to CxA and Designer for review.
  2. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
  3. Use only construction checklists, marked "Approved for Use, (date)" when performing tests. Mark construction checklists in the appropriate place, as indicated Project events are completed and provide pertinent details and other information.
- C. Systems required to be commissioned:

1. Heating, ventilating, air-conditioning, and refrigeration systems (mechanical and/or passive) and associated controls.
- D. Additional systems required to be commissioned:
1. Cooling generation systems, including the following:
    - a. Direct-expansion refrigeration systems.
  2. Air-handling systems, including the following:
    - a. Supply, return, and exhaust air fans, motors, and drives.
    - b. Automatic and gravity dampers.
    - c. Heating and cooling devices.
    - d. Humidification and dehumidification devices.
    - e. Air filters.
    - f. Hangers and supports.
    - g. Interlock between air-handling system and fire/smoke alarm system.
  3. Air duct systems, including the following:
    - a. Duct systems.
    - b. Air-duct accessories, including volume dampers, fire and smoke dampers, turning vanes, sound attenuators, and flexible connectors.
    - c. Duct-mounted access doors and panels.
    - d. Hangers and supports.
  4. Refrigerant piping, including the following:
    - a. Refrigerant piping, fittings, and specialties.
    - b. Refrigerant charge.
    - c. Sleeves and sleeve seals.
    - d. Meters and gauges.
    - e. General-duty and specialty valves.
    - f. Hangers and supports.
  5. Smoke-control systems, including the following:
    - a. Smoke detectors.
    - b. Fire and smoke alarm system interface.
  6. Heating and cooling terminal and unitary equipment, including the following:
    - a. Unit ventilators.
    - b. Unit heaters.
    - c. Fan-coil units.
    - d. Electric heating.
    - e. Unitary heating and cooling equipment.
  7. Vibration isolation systems.
  8. TAB Verification:
    - a. Airflow.
    - b. Space pressurization.

- 9. Documentation:
  - a. Mechanical systems manuals.
  - b. Documentation of required commissioning.
- 10. Mechanical insulation, including the following:
  - a. Duct and plenum insulation.
  - b. HVAC piping insulation.

### 3.03 CX TESTING PREPARATION

- A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.
- B. Certify that HVAC instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.
- C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

### 3.04 CX TEST CONDITIONS

- A. Perform tests using design conditions, whenever possible.
  - 1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
  - 2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
  - 3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
- B. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.
- C. If seasonal testing is specified, complete appropriate initial performance tests and documentation, and schedule seasonal tests.

### 3.05 CX TESTS COMMON TO HVAC SYSTEMS

- A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

- B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response in accordance with acceptance criteria.
- C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.
- D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 23 Sections specifying HVAC systems and equipment.
- E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:
  - 1. Cx Construction Checklist verification tests.
  - 2. Cx Construction Checklist verification test demonstrations.

### 3.06 TAB VERIFICATION

- A. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
- B. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
- C. Scope: HVAC air systems and hydronic piping systems.
- D. Purpose: Differential flow relationships intended to maintain air and water pressurization differentials between the various areas of Project.
- E. Conditions of the Test:
  - 1. Cx Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
  - 2. Systems operating in full heating mode **with minimum outside-air volume.**
  - 3. Systems operating in full cooling mode **with minimum outside-air volume.**
  - 4. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.
- F. Acceptance Criteria:
  - 1. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
  - 2. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than the tolerances allowed.
  - 3. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

**END OF SECTION**

## SECTION 23 09 23.12 - CONTROL DAMPERS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
1. Rectangular control dampers.
  2. Electric and electronic control damper actuators.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of damper and actuator:
1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
  3. Product description with complete technical data, performance curves, and product specification sheets.
  4. Installation instructions, including factors affecting performance.
- B. Delegated Design Submittal:
1. Schedule and design calculations for control dampers and actuators, including the following.
    - a. Flow at project design and minimum flow conditions.
    - b. Face velocity at project design and minimum airflow conditions.
    - c. Pressure drop across damper at project design and minimum airflow conditions.
    - d. AMCA 500D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
    - e. Maximum close-off pressure.
    - f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
    - g. Torque required at worst case condition for sizing actuator.
    - h. Actuator selection indicating torque provided.

#### 1.03 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For control dampers to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
- D. Selection Criteria:
  - 1. Fail positions unless otherwise indicated:
    - a. Supply Air: Open.
    - b. .
  - 2. Dampers shall have stable operation throughout full range of operation, from design to minimum airflow over varying pressures and temperatures encountered.
  - 3. Two-position dampers shall be full size of duct or equipment connection unless otherwise indicated.

### 2.02 RECTANGULAR CONTROL DAMPERS

- A. General Requirements:
  - 1. Unless otherwise indicated, use parallel blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed blade configuration.
  - 2. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
  - 3. Damper actuator shall be factory installed by damper manufacturer as integral part of damper assembly. Coordinate actuator location and mounting requirements with damper manufacturer.
- B. Rectangular Dampers with Steel Airfoil Blades:
  - 1. Performance:
    - a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-in. wg differential static pressure.
    - b. Pressure Drop: 0.06-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
    - c. Velocity: Up to 6000 fpm.
    - d. Temperature: Minus 40 to plus 185 deg F.
    - e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
    - f. Damper shall have AMCA seal for both air leakage and air performance.
  - 2. Construction:



- a. Frame:
  - 1) Material: ASTM A653/A653M galvanized-steel profiles, 0.06 inch thick.
  - 2) Hat-shaped channel with integral flanges. Mating face shall be a minimum of 1 inch.
  - 3) Width not less than 5 inches.
- b. Blades:
  - 1) Hollow, airfoil, galvanized steel.
  - 2) Parallel or opposed blade configuration as required by application.
  - 3) Material: ASTM A653/A653M galvanized steel, 0.05 inch thick.
  - 4) Width not to exceed 6 inches.
  - 5) Length as required by close-off pressure, not to exceed 48 inches.
- c. Seals:
  - 1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
  - 2) Jams: Stainless steel, compression type.
- d. Axles: 0.5-inch- diameter plated steel, mechanically attached to blades.
- e. Bearings:
  - 1) Stainless steel mounted in frame.
  - 2) Where blade axles are installed in vertical position, provide thrust bearings.
- f. Linkage:
  - 1) Concealed in frame.
  - 2) Constructed of aluminum and plated steel.
  - 3) Hardware: Stainless steel.
- g. Transition:
  - 1) Factory mount damper in a sleeve with a close transition to mate to field connection.
  - 2) Damper size and sleeve shall be connection size plus 2 inches.
  - 3) Sleeve length shall be not less than 12 inches for dampers without jackshafts and shall be not less than 16 inches for dampers with jackshafts.
  - 4) Sleeve material shall match adjacent duct.

## 2.03 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

- A. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.
- B. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.
- C. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.

- D. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.
- E. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.
- F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
- G. Provide mounting hardware and linkages for connecting actuator to damper.
- H. Select actuators to fail in desired position in the event of a power failure.

#### 2.04 ELECTRIC AND ELECTRONIC CONTROL DAMPER ACTUATORS

- A. Type: Motor operated, with or without gears, electric and electronic.
- B. Voltage:
  - 1. 24 V.
  - 2. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
  - 3. Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.
- C. Construction:
  - 1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
  - 2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
  - 3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
- D. Field Adjustment:
  - 1. Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.
  - 2. Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.
- E. Two-Position Actuators: Single direction, spring return or reversing type.
- F. Position Feedback:
  - 1. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
  - 2. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.
- G. Fail-Safe:
  - 1. Where indicated, provide actuator to fail to an end position.

2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
- H. Damper Attachment:
1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
  2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
  3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.
- I. Enclosure:
1. Suitable for ambient conditions encountered by application.
  2. NEMA 250, Type 2 for indoor and protected applications.
- J. Stroke Time:
1. Operate damper from fully closed to fully open within 15 seconds.
  2. Operate damper from fully open to fully closed within 15 seconds.
  3. Move damper to failed position within 15 seconds.
  4. Select operating speed to be compatible with equipment and system operation.
- K. Sound:
1. Spring Return: 62 dBA.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 CONTROL-DAMPER APPLICATIONS**

- A. Control Dampers:
- B. Select from damper types indicated in "Control Dampers" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
  1. Rectangular Supply Air Duct Applications: Rectangular dampers with steel airfoil blades.

### 3.03 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.
- C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Seal penetrations made in fire-rated and acoustically rated assemblies.
- E. Fastening Hardware:
  - 1. Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

### 3.04 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.

### 3.05 CONTROL DAMPERS

- A. Clearance:
  - 1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
- B. Service Access:
  - 1. Dampers and actuators shall be accessible for visual inspection and service.
  - 2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator.
- C. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
- D. Attach actuator(s) to damper drive shaft.
- E. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

### 3.06 CHECKOUT PROCEDURES

#### A. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check dampers for proper location and accessibility.
3. Verify that control dampers are installed correctly for flow direction.
4. Verify that proper blade alignment, either parallel or opposed, has been provided.
5. Verify that damper frame attachment is properly secured and sealed.
6. Verify that damper actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that damper blade travel is unobstructed.

### 3.07 ADJUSTMENT, CALIBRATION, AND TESTING:

- A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
- B. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

**END OF SECTION 23 09 23.12**

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## SECTION 23 23 00 - REFRIGERANT PIPING

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Copper tube and fittings.
  - 2. Valves and specialties.
  - 3. Refrigerants.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of valve, refrigerant piping, and piping specialty.
  - 1. Include pressure drop, based on manufacturer's test data, for the following:
    - a. Thermostatic expansion valves.
    - b. Filter dryers.
    - c. Strainers.

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

#### 1.05 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

#### 1.06 PRODUCT STORAGE AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
  - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
  - 2. Suction Lines for Heat-Pump Applications: 535 psig.
  - 3. Hot-Gas and Liquid Lines: 535 psig.

### 2.02 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings, Solder-Joint: ASME B16.22.
- C. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

### 2.03 VALVES AND SPECIALTIES

- A. Packed-Angle Valves:
  - 1. Body and Bonnet: Forged brass or cast bronze.
  - 2. Packing: Molded stem, back seating, and replaceable under pressure.
  - 3. Operator: Rising stem.
  - 4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
  - 5. Seal Cap: Forged-brass or valox hex cap.
  - 6. End Connections: Socket, union, threaded, or flanged.
  - 7. Working Pressure Rating: 500 psig.
  - 8. Maximum Operating Temperature: 275 deg F.
- B. Service Valves:
  - 1. Body: Forged brass with brass cap including key end to remove core.
  - 2. Core: Removable ball-type check valve with stainless-steel spring.
  - 3. Seat: Polytetrafluoroethylene.
  - 4. End Connections: Copper spring.
  - 5. Working Pressure Rating: 500 psig.
- C. Refrigerant Locking Caps:
  - 1. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant charging ports from unauthorized refrigerant access and leakage.
  - 2. Material: Brass, with protective shroud or sleeve.
  - 3. Refrigerant Identification: Universal design.
  - 4. Special Tool: For installing and unlocking.
- D. Thermostatic Expansion Valves: Comply with AHRI 750.
  - 1. Body, Bonnet, and Seal Cap: Forged brass or steel.



2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Reverse-flow option (for heat-pump applications).
7. End Connections: Socket, flare, or threaded union.

E. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

F. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

G. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

H. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Designed for reverse flow (for heat-pump applications).
4. End Connections: Socket.
5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

## 2.04 REFRIGERANTS

- A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

## **PART 3 - EXECUTION**

### **3.01 PIPING APPLICATIONS FOR REFRIGERANT R-410A**

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Hot-Gas and Liquid Lines :
  - 1. Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

### **3.02 VALVE AND SPECIALTY APPLICATIONS**

- A. Install packed-angle valves in suction and discharge lines of compressor.
- B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install thermostatic expansion valves as close as possible to distributors on evaporators.
  - 1. Install valve so diaphragm case is warmer than bulb.
  - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
  - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- D. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- E. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
  - 1. Thermostatic expansion valves.
  - 2. Compressor.
- F. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- G. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to the authority having jurisdiction.

### **3.03 INSTALLATION OF PIPING, GENERAL**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.

- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- L. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Liquid lines may be installed level.
- M. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- N. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

### 3.04 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

### 3.05 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

- B. Support horizontal piping within 12 inches of each fitting.
- C. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.06 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Comply with ASME B31.5, Chapter VI.
  - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System shall maintain test pressure at the manifold gage throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

### 3.07 SYSTEM CHARGING

- A. Charge system using the following procedures:
  - 1. Install core in filter dryers after leak test but before evacuation.
  - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
  - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
  - 4. Charge system with a new filter-dryer core in charging line.

### 3.08 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- C. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  - 1. Open shutoff valves in condenser water circuit.
  - 2. Verify that compressor oil level is correct.
  - 3. Open compressor suction and discharge valves.
  - 4. Open refrigerant valves except bypass valves that are used for other purposes.
  - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- D. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

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## SECTION 23 31 13 - METAL DUCTS

### PART 1 - GENERAL

#### 1.01 SUMMARY

##### A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

#### 1.02 ACTION SUBMITTALS

##### A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

##### B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main all duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
13. .

##### C. Delegated Design Submittals:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports are to withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
- C. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

### 2.02 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
  - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
  - 2.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1.
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."



## 2.03 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
- B. Source Limitations: Obtain single-wall round ducts and fittings from single manufacturer.
- C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.04 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch- minimum diameter for lengths longer than 36 inches.

## 2.05 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Source Limitations: Obtain fibrous-glass duct liner from single manufacturer.
  - 2. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
  - 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating.

Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - a. Fan discharges.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.06 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.

6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- 10.

C. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

## 2.07 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
  3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## PART 3 - EXECUTION

### 3.01 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
- B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- J. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.
- L. Elbows: Use long-radius elbows wherever they fit.
  - 1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
  - 2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.
- M. Branch Connections: Use lateral or conical branch connections.

### 3.02 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- D. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.03 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.

3. Conditioned Space, Exhaust Ducts: Seal Class B.
4. Conditioned Space, Return-Air Ducts: Seal Class C.

#### 3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- E. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

#### 3.05 DUCTWORK CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

#### 3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Duct System Cleanliness Tests:
  1. Visually inspect duct system to ensure that no visible contaminants are present.
- C. Duct system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

#### 3.07 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use duct cleaning methodology as indicated in NADCA ACR.
- C. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

D. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

E. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.08 STARTUP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

### 3.09 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
  - 1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
- B. Supply Ducts:
  - 1. Ducts Connected to Constant-Volume Air-Handling Units:
    - a. Pressure Class: Positive 2- inch wg.
    - b. Minimum SMACNA Seal Class: B.
- C. Return Ducts:
  - 1. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2- inch wg.
    - b. Minimum SMACNA Seal Class: C.
- D. Exhaust Ducts:
  - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    - a. Pressure Class: Negative 1- inch wg.
    - b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
  - 1. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2- inch wg.
    - b. Minimum SMACNA Seal Class: B.
- F. Intermediate Reinforcement:
  - 1. Galvanized-Steel Ducts: Galvanized steel.
- G. Liner:
  - 1. Supply-Air Ducts: Fibrous glass, Type I, 1 inch thick.
  - 2. Return-Air Ducts: Fibrous glass, Type I, 1 inch thick.
- H. Elbow Configuration:
  - 1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
    - a. Velocity 1000 fpm or Lower:
      - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      - 2) Mitered Type RE 4 without vanes.

- b. Velocity 1000 to 1500 fpm:
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  - c. Velocity 1500 fpm or Higher:
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct - Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
- a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
    - 4) Radius-to Diameter Ratio: 1.5.
  - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
  - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- I. Branch Configuration:
- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
    - a. Rectangular Main to Rectangular Branch: 45-degree entry.
    - b. Rectangular Main to Round Branch: Conical spin in.
  - 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.



- a. Velocity 1000 fpm or Lower: 90-degree tap.
- b. Velocity 1000 to 1500 fpm: Conical tap.
- c. Velocity 1500 fpm or Higher: 45-degree lateral.

**END OF SECTION 23 31 13**

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## SECTION 23 33 00 - AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.01 SUMMARY

##### A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Flange connectors.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.

#### 1.02 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

##### B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
  - a. Special fittings.
  - b. Manual volume damper installations.
  - c. Control-damper installations.
  - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
  - e. Duct security bars.

#### 1.03 CLOSEOUT SUBMITTALS

##### A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

### 2.02 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Description: Gravity balanced.
- B. Performance:
  - 1. Maximum Air Velocity: 1250 fpm.
  - 2. Maximum System Pressure: 3 inches wg.
  - 3.
  - 4. Leakage:
    - a. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
- C. Construction:
  - 1. Frame:
    - a. Hat shaped.
    - b. 0.093-inch- thick extruded aluminum, with welded or mechanically attached corners and mounting flange.
  - 2. Blades:
    - a. Multiple single-piece blades.
    - b. Center pivoted, maximum 6-inch width, 0.050-inch- thick aluminum sheet with sealed edges.
  - 3. Blade Action: Parallel.
- D. Blade Seals: Neoprene, mechanically locked.
- E. Blade Axles:
  - 1. Material: Aluminum.
  - 2. Diameter: 0.20 inch.
- F. Tie Bars and Brackets: Aluminum.
- G. Return Spring: Adjustable tension.

- H. Bearings: synthetic pivot bushings.

## 2.03 MANUAL VOLUME DAMPERS

### A. Standard, Steel, Manual Volume Dampers:

1. Performance:
  - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
2. Construction:
  - a. Linkage out of airstream.
  - b. Suitable for horizontal or vertical airflow applications.
3. Frames:
  - a. Hat-shaped, 16-gauge- thick, galvanized sheet steel.
  - b. Mitered and welded corners.
  - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
  - a. Multiple or single blade.
  - b. Parallel- or opposed-blade design.
  - c. Stiffen damper blades for stability.
  - d. Galvanized steel; 16 gauge thick.
5. Blade Axles: Galvanized steel.
6. Tie Bars and Brackets: Galvanized steel.
7. Locking device to hold damper blades in a fixed position without vibration.

## 2.04 CONTROL DAMPERS

### A. General Requirements:

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

### B. Performance:

- 1.
2. Leakage:
  - a. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.

3. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm.
5. Temperature: Minus 25 to plus 180 deg F.
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

C. Construction:

1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:
  - a. Hat, U, or angle shaped.
  - b. 16-gauge- thick, galvanized sheet steel.
  - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
  - a. Multiple blade with maximum blade width of 6 inches.
  - b. Parallel -blade design.
  - c. Galvanized steel.
  - d. 16-gauge- thick single skin.
5. Blade Edging Seals:
  - a. Replaceable Closed-cell neoprene.
  - b. Inflatable seal blade edging, or replaceable rubber seals.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch diameter; galvanized steel.
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings:
  - a. Molded synthetic.
  - b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

D. Damper Actuator - Electric:

1. Electric - 24 V ac.
2. UL 873, plenum rated.
3. Two position with fail-safe spring return.
  - a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
  - b. Minimum 90-degree drive rotation.
4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:
  - a. Temperature: Minus 40 to plus 130 deg F.
  - b. Humidity: 5 to 95 percent relative humidity noncondensing.

6. Environmental enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

## 2.05 FLANGE CONNECTORS

- A. Description: roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.
- B. Material: Galvanized steel.
- C. Gauge and Shape: Match connecting ductwork.

## 2.06 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
  1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- D. Vane Construction:
  1. Double wall.

## 2.07 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."
  1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. 24-gauge- thick galvanized steel door panel.
    - d. Vision panel.
    - e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    - f. Fabricate doors airtight and suitable for duct pressure class.
  2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
    - a. 24-gauge- thick galvanized steel or 0.032-inch- thick aluminum Insert value frame.

3. Number of Hinges and Locks:

- a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
- b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
- c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches.
- d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.08 FLEXIBLE CONNECTORS

- A. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Materials: Flame-retardant or noncombustible fabrics.
- D. Coatings and Adhesives: Comply with UL 181, Class 1.
- E. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches Insert dimension wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- F. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd..
  - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F.

2.09 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.10 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Exposed-Surface Finish: Mill phosphatized.



## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.
- C. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. At outdoor-air intakes and mixed-air plenums.
  - 2. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  - 3. Upstream from turning vanes.
  - 4. Control devices requiring inspection.
  - 5. Elsewhere as indicated.
- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 8 by 5 inches.
  - 2. Two-Hand Access: 12 by 6 inches.
  - 3. Head and Hand Access: 18 by 10 inches.
  - 4. Head and Shoulders Access: 21 by 14 inches.
  - 5. Body Access: 25 by 14 inches.
- J. Install flexible connectors to connect ducts to equipment.
- K. Install duct test holes where required for testing and balancing purposes.
- L. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

### 3.02 FIELD QUALITY CONTROL

#### A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.

**END OF SECTION 23 33 00**

## SECTION 23 37 13.13 - AIR DIFFUSERS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Rectangular and square ceiling diffusers.
  - 2. High-capacity drum louver diffusers.
  - 3. High-capacity, modular-core supply grille diffusers.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

### PART 2 - PRODUCTS

#### 2.01 RECTANGULAR AND SQUARE CEILING DIFFUSERS

- A. Devices shall be specifically designed for variable-air-volume flows.
- B. Material: Steel.
- C. Finish: Baked enamel, white.
- D. Face Size: 24 by 24 inches.
- E. Face Style: Four cone.
- F. Mounting: Surface.
- G. Pattern: Fixed.

#### 2.02 HIGH-CAPACITY DRUM LOUVER DIFFUSERS

- A. Airflow Principle: Extended distance for high airflow rates.
- B. Material: Aluminum, heavy gage extruded.
- C. Finish: White baked acrylic.

- D. Border: 1-1/4-inch width with countersunk screw holes.
- E. Gasket between drum and border.
- F. Body: Drum shaped; adjustable vertically.
- G. Blades: Individually adjustable horizontally.
- H. Mounting: Surface to duct.

#### 2.03 HIGH-CAPACITY, MODULAR-CORE SUPPLY GRILLE DIFFUSERS

- A. Throw: Extended distance for airflow rates.
- B. Material: Steel.
- C. Grilles per Unit: Four.
- D. Finish: White baked acrylic.
- E. Border: 1-1/2-inch width with countersunk screw holes.
- F. Blades:
  - 1. Airfoil, individually adjustable horizontally.
  - 2. Double deflection.
  - 3. Set in modules.
- G. Modules: Removable; rotatable.
- H. Mounting: Surface.
- I. Accessory: Opposed-blade steel damper.

#### 2.04 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION

- A. Install diffusers level and plumb.
- B. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 23 37 13.13**

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## SECTION 23 37 13.23 - REGISTERS AND GRILLES

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Adjustable blade face registers.
  - 2. Fixed face grilles.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

### PART 2 - PRODUCTS

#### 2.01 REGISTERS

- A. Adjustable Blade Face Register:
  - 1. Material: Steel.
  - 2. Finish: Baked enamel, white.
  - 3. Face Blade Arrangement: Vertical spaced 3/4 inch apart.
  - 4. Core Construction: Integral.
  - 5. Rear-Blade Arrangement: Horizontal spaced 3/4 inch apart.
  - 6. Frame: 1-1/4 inches wide.
  - 7. Mounting: Countersunk screw.

#### 2.02 GRILLES

- A. Fixed Face Grille Insert drawing designation:
  - 1. Material: Steel.
  - 2. Finish: Baked enamel, white.
  - 3. Face Blade Arrangement: Vertical; spaced 3/4 inch apart.
  - 4. Face Arrangement: Perforated core.
  - 5. Core Construction: Integral.
  - 6. Frame: 1-1/4 inches wide.
  - 7. Mounting: Countersunk screw.

## 2.03 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### 3.03 ADJUSTING

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 23 37 13.23**



## SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

#### 1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

#### 1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One set(s) for each air-handling unit.
  - 2. Gaskets: One set(s) for each access door.
  - 3. Fan Belts: One set(s) for each air-handling unit fan.

#### 1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."

- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

#### 1.07 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

#### 1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

- a. For Compressor: Five year(s) from date of Substantial Completion.
- b. For Parts: Five year(s) from date of Substantial Completion.
- c. For Labor: Five year(s) from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.01 INDOOR UNITS (5 TONS OR LESS)

- A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements
  - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - c. Enclosure Type: Totally enclosed, fan cooled.
  - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
  - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
  - f. Mount unit-mounted disconnect switches on exterior of unit.
  - g. .

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Condensate Drain Pans:
  - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
    - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
    - 2) Depth: A minimum of 1 inch deep.
  - b. Single-wall, galvanized -steel sheet.
  - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
    - 1) Minimum Connection Size: NPS 1.
  - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
7. Air Filtration Section:
  - a. General Requirements for Air Filtration Section:
    - 1) Comply with NFPA 90A.
    - 2) Minimum MERV according to ASHRAE 52.2.
    - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
  - b. Disposable Panel Filters:
    - 1) Factory-fabricated, viscous-coated, flat-panel type.
    - 2) Thickness: 1 inch.
    - 3) Media: Interlaced glass fibers sprayed with nonflammable adhesive.

## 2.02 INDOOR UNITS (6 TONS OR MORE)

- A. Floor-Mounted, Evaporator-Fan Components:
  1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
    - a. Discharge Grille: Steel with surface-mounted frame.
    - b. Insulation: Faced, glass-fiber duct liner.
  2. Condensate Drain Pans:
    - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
      - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.

- 2) Depth: A minimum of 2 inches deep.
- b. Single-wall, stainless-steel sheet.
- c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
- 1) Minimum Connection Size: NPS 1.
- d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
- e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
- 4. Fan: Direct drive, centrifugal.
- 5. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements
  - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - c. Enclosure Type: Totally enclosed, fan cooled.
  - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
  - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
  - f. Mount unit-mounted disconnect switches on exterior of unit.
  - g. .
- 6. Air Filtration Section:
  - a. General Requirements for Air Filtration Section:
    - 1) Comply with NFPA 90A.
    - 2) Minimum MERV according to ASHRAE 52.2.
    - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
  - b. Disposable Panel Filters:
    - 1) Factory-fabricated, viscous-coated, flat-panel type.
    - 2) Thickness: 2 inches.
    - 3) MERV according to ASHRAE 52.2: 8.
    - 4) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.
- B. Variable-Frequency Controllers:
  - 1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, three-phase induction motor by adjusting output voltage and frequency.
  - 2. Output Rating: Three-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
  - 3. Unit Operating Requirements:
    - a. Input ac voltage tolerance of 208 V, plus or minus 5 percent.

- b. Input-frequency tolerance of 06/11 Hz, plus or minus 6 percent.
  - c. Minimum Efficiency: 96 percent at 60 Hz, full load.
  - d. Minimum Displacement Primary-Side Power Factor: 96 percent.
  - e. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
  - f. Starting Torque: 100 percent of rated torque or as indicated.
  - g. Speed Regulation: Plus or minus 1 percent.
- 4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
- 5. Internal Adjustability Capabilities:
  - a. Minimum Speed: 5 to 25 percent of maximum rpm.
  - b. Maximum Speed: 80 to 100 percent of maximum rpm.
  - c. Acceleration: 2 seconds to a minimum of 22 seconds.
  - d. Deceleration: 2 seconds to a minimum of 22 seconds.
  - e. Current Limit: 50 percent to a minimum of 110 percent of maximum rating.
- 6. Self-Protection and Reliability Features:
  - a. Input transient protection by means of surge protection devices (SPDs).
  - b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
  - c. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
  - d. Instantaneous line-to-line and line-to-ground overcurrent trips.
  - e. Loss-of-phase protection.
  - f. Reverse-phase protection.
  - g. Short-circuit protection.
  - h. Motor overtemperature fault.
- 7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads, spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- 8. Power-Interruption Protection: Prevents motor from re-energizing after a power interruption until motor has stopped.
- 9. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- 10. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back, based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- 11. Meters or digital readout devices and selector switch, mounted flush in controller door and connected, to indicate the following controller parameters:
  - a. Output frequency (Hertz).
  - b. Motor speed (rpm).
  - c. Motor status (running, stop, fault).
  - d. Motor current (amperes).
  - e. Motor torque (percent).
  - f. Fault or alarming status (code).
  - g. Proportional-integral-derivative feedback signal (percent).
  - h. DC-link voltage (volts dc).
  - i. Set-point frequency (Hertz).
  - j. Motor output voltage (volts).

12. Control Signal Interface:

- a. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.
- b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
  - 1) 0 to 10-V dc.
  - 2) 0-20 or 4-20 mA.
  - 3) Potentiometer using up/down digital inputs.
  - 4) Fixed frequencies using digital inputs.
  - 5) RS485.
  - 6) Keypad display for local hand operation.
- c. Output signal interface with a minimum of one analog output signal (0/4-20 mA), which can be programmed to any of the following:
  - 1) Output frequency (Hertz).
  - 2) Output current (load).
  - 3) DC-link voltage (volts dc).
  - 4) Motor torque (percent).
  - 5) Motor speed (rpm).
  - 6) Set-point frequency (Hertz).
- d. Remote indication interface with a minimum of two dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
  - 1) Motor running.
  - 2) Set-point speed reached.
  - 3) Fault and warning indication (overtemperature or overcurrent).
  - 4) High- or low-speed limits reached.

13. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

2.03 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

- 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - a. Compressor Type: Scroll.
  - b. Refrigerant: R-410A.
  - c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
- 3. Fan: Aluminum-propeller type, directly connected to motor.

4. Motor: Permanently lubricated, with integral thermal-overload protection.

## 2.04 OUTDOOR UNITS (6 TONS OR MORE)

### A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - a. Compressor Type: Scroll.
  - b. Refrigerant: R-410A.
  - c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to 45 deg F.

## 2.05 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
  1. Compressor time delay.
  2. 24-hour time control of system stop and start.
  3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
  4. Fan-speed selection including auto setting.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- E. Drain Hose: For condensate.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

- C. Equipment Mounting:
  - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
- D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

### 3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section 23 31 13 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 23 33 00 "Air Duct Accessories."

### 3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

### 3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. .



3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

**END OF SECTION 23 81 26**

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## SECTION 23 82 39.19 - WALL AND CEILING UNIT HEATERS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

#### 1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

#### 1.03 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.01 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

#### 2.02 CABINET

- A. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
- B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

#### 2.03 COIL

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath.

Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection.

**2.04 FAN AND MOTOR**

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricated. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

**2.05 CONTROLS**

- A. Controls: Remote mounted thermostat.
- B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

**PART 3 - EXECUTION**

**3.01 EXAMINATION**

- A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.02 INSTALLATION**

- A. Install wall and ceiling unit heaters to comply with NFPA 90A.
- B. Install wall and ceiling unit heaters level and plumb.
- C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

**END OF SECTION 23 82 39.19**

**SECTION 26 05 00****COMMON WORK RESULTS FOR ELECTRICAL****PART 1 - GENERAL****1.01 SUMMARY**

- A. General: The general electrical requirements in this section are applicable to both Parsons' Furnished Equipment and non-Parsons' furnished equipment. Materials and equipment must comply with requirements of the contract documents. Materials furnished must be new, the standard products of manufacturers regularly engaged in the production of such materials, and of the manufacturer's latest designs that comply with the specification requirements. If material and equipment requirements conflict, the order of precedence for selection must be as follows:
1. The contract specifications, the contract drawings.
  2. Federal Aviation Administration specifications and standards.
  3. Contract drawings.
  4. NFPA-70 National Electrical Code.
  5. UL Standards and NEMA Standards.
  6. IEEE Standards.
  7. Federal Specifications.
  8. Military Specifications.
- B. Wherever standards have been established by Underwriters Laboratories, Inc., the material must bear the UL label.

**1.02 ELECTRICAL CHARACTERISTICS**

- A. Provide the following electrical equipment and systems as directed in the project drawings:
1. Equipment, wiring devices and electrical connections required for installation of electrical equipment.
  2. Raceways and wiring for power and controls, including underground ductbanks.
  3. Grounding systems.
  4. Concrete equipment bases.
  5. Cutting and patching for electrical construction.
  6. Lightning protection system.
  7. Seismic bracing.
- B. Spacing Requirements:
1. Electrical equipment sizes indicated on the drawings are generally based on specified manufacturer. Verify that the equipment proposed will fit in the space indicated on the drawings. Coordinate building dimensions with architectural and structural drawings. Equipment furnished and installed under other Sections of this Specification must be coordinated with the requirements of this Section. Maintain space about equipment per the latest edition of NFPA 70 Article 110. Establish the exact location of electrical equipment based on the actual field verified dimensions of equipment furnished.
- C. For Official Use Only Departure from Dimensions Shown:

1. Minor departures from exact dimensions shown in electrical plans may be permitted when required to avoid conflict or unnecessary difficulty in placement of a dimensioned item, provided all contract requirements are met. Promptly obtain written approval from the Resident Engineer prior to undertaking any such departures and must provide appropriate documentation of the departure.

#### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product specified.
- B. Samples: When the adequacy, quality and safety of a material will be better demonstrated and it will expedite approval, provide single samples of items proposed for use. Conform to the procedures specified. Submit samples of color, lettering style, and other graphic representation required for each identification product for the project.

#### 1.04 QUALITY ASSURANCE

- A. Comply with latest edition of NFPA 70, FAA-STD-019, and FAA-C-1217 for components and installation. In case of conflict between provisions of codes, laws and ordinances, the more stringent requirement must apply.
- B. Listing and Labeling:
  1. Provide products specified in the Section that are listed and labeled. The terms "listed and labeled" as defined in the latest edition of NFPA 70, National Electrical Code, Article 100.
- C. Project Record Documents
  1. Maintain at the job site a separate set of white prints of the contract documents for the purpose of recording the system and dimension changes of those portions of work in which actual construction is at variance with the contract documents. Record changes for both Parsons' Provided Equipment and self-provided equipment. Upon acceptance of the project, submit documents to the Resident Engineer, with verification of data accuracy. Mark the drawings with colored pencil. Prepare the drawings as the work progresses. Upon completion of work submit drawings clearly indicating the following:
    - a. Locations of devices, raceways, equipment and other pertinent items. Schematic and interconnection wiring diagrams of the completed power and control system incorporating the data derived from the equipment shop drawings and the cable and raceway schedule. The drawings must be detailed to wire and terminal block numbers, conductor color coding, device designations locations and reflect identifications established at the site.
    - b. Cable and raceway schedule for cables and raceways actually installed; include the type, size, origin, destination, and approximate length for each cable and raceway.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Self-provided equipment must be protected from damage and stored in a dry location from the time of site delivery. Conduct routine inspections of stored equipment to check equipment condition. Follow the Manufacturer's directions for the delivery, storage, and handling of equipment and materials. Tightly cover equipment and materials and protect from dirt, water, chemical or mechanical injury and theft. Damaged equipment and material will not be acceptable. Upon

installation, protect the equipment and materials until work is completed and accepted by the Resident Engineer.

## 1.06 SEQUENCING AND SCHEDULING

- A. Coordinate electrical equipment installation with other building components.
  - 1. Coordinate electrical equipment installation with other building components.
  - 2. Coordinate installing of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
  - 3. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.
  - 4. Sequence, coordinate, and integrate installing of electrical materials and equipment for efficient flow of the work. Coordinate installing large equipment requiring positioning prior to closing in the building.
  - 5. Coordinate connecting the electrical service to components furnished under other Sections.
  - 6. Coordinate connecting electrical systems with exterior underground and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
  - 7. Coordinate installing of electrical identification after completion of finishing where identification is applied to field-finished surfaces.
- B. Interruption of Power:
  - 1. Be advised that the project site is a fully operational NAS facility that supports the airport and/or the NAS. An un-scheduled power interruption to any of the electrical distribution systems or an interruption of the communication systems is not allowed. Work requiring a temporary or permanent de-energizing of the electrical service must be scheduled and approved in writing by the Resident Engineer at least 14 calendar days in advance of performance of the work. Work may not commence until written authorization is received from the Resident Engineer.

## PART 2 - PRODUCTS

### 2.01 SUPPORTING DEVICES

- A. Channel and angle supports, raceway supports, sleeves and fasteners must be as specified in Section 26 05 29, "Hangers and Supports for Electrical Systems."

### 2.02 ELECTRICAL IDENTIFICATION

- A. Provide electrical identification as specified in Section 26 05 53, "Identification for Electrical Systems." Manufacturer's standard products to use colors prescribed by ANSI A13.1 and NFPA 70.

## **PART 3 - EXECUTION**

### **3.01 EQUIPMENT INSTALLATION REQUIREMENTS**

- A. Comply with NECA 1
- B. Materials and equipment must be installed in accordance with the contract drawings. Where manufacturer's recommended installation methods conflict with the contract requirements, difference must be resolved by the Resident Engineer. The installation must be accomplished by skilled workers regularly engaged in this type of work. A licensed Master Electrician must be required for all electrical equipment installation, raceway installation, wiring, and electrical tests. Electrical Apprentices may be used under the direct supervision of a Master Electrician.

### **3.02 EXCAVATION FOR ELECTRICAL WORK**

- A. Excavations must comply with civil specification requirements.

### **3.03 INSTALLATION**

- A. The rules, regulations, and reference documents indicated must be considered as minimum requirements and must not relieve provider from furnishing and installing higher grades of materials and workmanship than are specified or when required by the contract drawings. Equipment must be installed in a manner to provide proper working space, access, and space for removal of the equipment to suit intended application.
- B. Contract Drawings:
  - 1. Where the drawings schematically indicate the work, diagrammatically or otherwise, furnish and install equipment, material and labor for a complete and proper installation. Ensure that electrical and communications work is coordinated and compatible with Architectural, Mechanical, Structural, and Civil work.
- C. Fastening:
  - 1. Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure in accordance with Section 26 05 29, "Hangers and Supports for Electrical Systems."
- D. Concrete Pads:
  - 1. Install concrete pads and bases according to manufacturer requirements or general best practices.
- E. Identification Devices:
  - 1. Install identification devices where required in accordance with the requirements of Section 26 05 53, "Identification for Electrical Systems."



### 3.04 DEMOLITION

- A. Protect existing electrical equipment and installations when performing new work. If damaged or disturbed in the course of the work, remove damaged portions and install new products of equal capacity, quality, and functionality. Remove demolished material from the project site. Remove, store, clean, re-install, reconnect, and make operational components indicated for relocation.
- B. Accessible Work:
  - 1. Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- C. Abandoned Work:
  - 1. Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 feet below the surface of adjacent construction. Cap raceways and patch surface to match existing finish. Wire not removed must have the Resident Engineer's written approval.

### 3.05 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved. Repair disturbed surfaces to match adjacent undisturbed surfaces.

**END OF SECTION**

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**SECTION 26 05 00.10****BASIC ELECTRICAL MATERIALS AND METHODS****PART 1 - GENERAL****1.01 SUMMARY****A. Section includes:**

1. Furnish material, equipment, labor, and incidentals necessary for complete and operational systems as specified herein.
2. This section concerns all other sections in Division 26 and shall be considered a part of each of those sections as if written in their entirety.
3. The general electrical requirements in this section are applicable to both GFE and non-GFE equipment.
4. Replacement and spare parts shall be provided as indicated in other sections of Division 26.

**1.02 REFERENCE STANDARDS**

**A. General:** Comply with the standards in effect as of the date of the Contract Documents as applicable to the extent specified in this Division. The rules, regulations and reference specifications enumerated in these specifications shall be considered as minimum requirements. Adherence to other standards shall not relieve the subcontractor from furnishing and installing higher grades of materials and workmanship when so required by this specification. Adherence to this specification shall not relieve from furnishing and installing higher grades of materials and workmanship when so required by the Contract Drawings or special contracts provisions. Electrical work shall be executed in accordance with local, state, and national codes, ordinances, and regulations that have jurisdiction authority over the work. If conflicts occur between FAA documents and any other document, the FAA requirements shall be used.

1. Federal Aviation Administration (FAA)
  - a. FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment, latest edition
  - b. FAA-C-1217 Electrical Work, Premises Wiring, latest edition
  - c. FAA-C-1391 Installation, Termination, Splicing, and Transient/Surge Protection of Underground Electrical Distribution System Power Cables, latest edition
2. Institute of Electrical and Electronic Engineers (IEEE)
  - a. 519 Recommended Practices and Requirements for Harmonic Control and Electrical Power Systems
3. National Electrical Manufacturers Association (NEMA)
  - a. WC70-00 Non-Shielded Power Cable 2000V or Less
  - b. WC26-00 Binational Wire and Cable Packaging Standard
4. National Fire Protection Association (NFPA)

- a. 70 National Electrical Code (NEC), latest edition
- 5. National Electrical Contractors Association (NECA)
  - a. 1-2000 Standard of Installation
- 6. Occupational Safety and Health Administration (OSHA)
  - a. 29CFR1907 Description and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
- 7. Underwriters Laboratories (UL)
  - a. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
- 8. Federal Specifications:
  - a. J-C-30 Cable and Wire, Electrical (Power, Fixed Installation)
  - b. L-T-1512 Tape, Wrapping, Pressure-Sensitive; Adhesive Tape 1512
  - c. L-P-390 Plastic Molding and Extrusion Material, Polyethylene and Co-polymers Low, Medium Density
  - d. W-C-582 Raceway, Metal and Fittings: Surface
  - e. W-C-586 Raceway Outlets, Boxes, Bodies, and Entrance Caps, Electrical; Cast Metal – For Shore Use
  - f. W-F-406 Fittings for Cable, Power, Electrical and Raceway, Metal Flexible
  - g. W-F-408 Fittings for Raceway, Metal, Rigid (Thick-Wall and Thin Wall (EMT-Type))
  - h. W-S-610 Splice, Conductor
  - i. HH-I-510 Insulation Tape, Electrical, Friction
  - j. HH-I-595 Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic, or Low Temperature Application
  - k. W-C-563 Raceway, Metal, Rigid; and Bends and Elbows, Electrical Raceway: Thin Walled Type (EMT)
  - l. W-C-566 Raceway, Metal, Flexible
  - m. W-C-581 Raceway, Metal, Rigid and Intermediate; Coupling, Elbow, Nipple, Electrical Raceway: Zinc-Coated

### 1.03 JOB CONDITIONS

- A. Obtain and pay for all permits, licenses, and inspection completion as required by law for the completion of the work. Certificates of approval shall be secured, paid for and delivered to the Contractor before receiving the acceptance of the work.
- B. The location of materials, equipment, devices, and appliances indicated are approximate and subject to revisions at the time of installation. The Contract Drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements.
- C. Should project conditions require any rearrangement of work, or if equipment or accessories can be installed to a better advantage than the general arrangement of work on the plans, prepare and submit plans of the proposed rearrangement to the WRPM before proceeding with the work.

- D. Equipment Size: Electrical equipment size indicated on the Contract Drawings is based on a particular manufacturer. Verify that the equipment proposed to furnish will fit in the space indicated on the Drawings.
- E. Equipment Coordination: Equipment furnished and installed under other Sections of this Specification shall be coordinated with equipment furnished and installed under this section.
- F. Supervision: Electrical work shall be performed under the supervision of a master Electrician who holds a valid license.
- G. Code Violations: Perform work to meet or exceed the requirements of the National Electrical Code and other applicable statutes, ordinances, codes, and regulations of the governmental authorities having jurisdiction. Resolve any code violations discovered in the Contract Documents with the Subcontracts Administrator prior to award of the Contract.
- H. After Contract award, make any corrections or additions necessary for the compliance with applicable codes at no additional cost to the Government.

#### 1.04 GUARANTEES

- A. The work shall be guaranteed for one year from the date of final acceptance of the project and any faults or imperfections that may rise due to defects of omissions in materials or workmanship must be repaired at own expense during that period.

#### 1.05 ACTION SUBMITTALS

- A. Parsons WRPM approval is required for all submittals. Submit the following:
  - 1. Manufacturer's data sheets: Component catalog numbers and manufacturer's data sheets, including pertinent data identifying each component by the item number and nomenclature, as specified.
  - 2. List of equipment and principal materials: Within 5 days after the Notice of Award (NOA) of the contract and before orders are placed or shop drawings are submitted, the Subcontractor shall submit to the WRPM a list of equipment and principal materials specified. Give names and manufacturer's catalog and model numbers and other such supplemental information as necessary for identification.
  - 3. Project Record Documents: Maintain at the job site a separate set of redline bond prints of the Contract Documents (specifications, drawings, change orders, addendums) for the purpose of recording the system and dimension changes of those portions of work in which actual construction is significantly at variance with the Contract Documents. The Subcontractor shall record changes for both GFE and Subcontractor provided equipment. Upon acceptance of the project, submit documents to the WRPM, with verification of data accuracy. Mark the Record Drawings with colored pencil. Prepare the Record Drawings as the work progresses. Upon completion of work, submit Record Drawings clearly indicating the following:
    - a. Locations of devices, raceways, equipment and other pertinent items; Indicate the depth of buried ducts and direct burial cables.
    - b. Schematic and interconnection wiring diagrams of the completed power and control system incorporating the data derived from the equipment shop drawings, and the cable and raceway schedule. The drawings shall be detailed to wire and terminal block numbers, conductor color coding, device designations, locations, and reflect identifications established at the site.

4. Test Report: Submit a summary of the Electrical Test Report and Motor Test Report, noting deviations from requirements listed below:
  - a. Maximum plus or minus five percent variation between nominal system voltage and no load voltage.
  - b. Maximum plus or minus ten percent variation between average phase current and measured individual phase currents for panelboards.

#### 1.06 QUALITY CONTROL

- A. General: The rules, regulations and reference specifications enumerated herein shall be considered as minimum requirements and shall not relieve the Subcontractor from furnishing and installing higher grades of material and workmanship than are specified herein or when so required by the Contract Drawings. Materials, appliances, and equipment provided shall meet the requirements of the Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories (ETL) and other standard organizations. This specification shall govern when conflicts occur between reference documents and this specification.
- B. Electrical Qualification: Use adequate numbers of skilled workmen, trained and experienced in their crafts, and who are familiar with the specifications and methods of performing the work in this Division.
- C. Licensed: The electrical foreman shall be a licensed master electrician.
- D. Workmanship: Work shall be performed in accordance with quality, commercial practices. The appearance of finished work shall be of equal importance with its operation. Material and equipment shall be installed based upon the actual dimensions and conditions at the project site. Locations for materials or equipment requiring exact fit shall be field measured. Raceway, transformers, and motors shall be isolated to avoid unacceptable noise levels from objectionable vibrations from all systems.
- E. Contract Drawings: Where the electrical drawings indicate (diagrammatically or otherwise) the work intended and the function to be performed even though some minor details are not shown, furnish all equipment, material (other than Government Furnished Equipment), and labor to complete the installation work and accomplish all indicated functions of the electrical installation. Ensure that all electrical work is coordinated and compatible with all other disciplines, general, NFPA 70 latest edition, and FAA Standards.
- F. View Other Sections: Review other sections of this specification to determine electrical requirements for equipment furnished under those sections. Coordinate all electrical rough-ins and connections for proper function of this equipment.
- G. Listing and Labeling: Provide products specified in the section that are listed and labeled:
  1. The terms "Listed and Labeled" as defined in the National Electrical Code, (latest edition) Article 100.
  2. Listing and Labeling Agency Qualifications: NRTL as defined in OSHA Regulation 1910.7.
  3. Field installed nameplates shall conform to Division 26 05 53, Identification of Electrical Systems.
  4. Nameplates on manufactured items shall be aluminum or type 304 stainless steel not less than 20 US Gauge, riveted, bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of the equipment data.

## **PART 2 - PRODUCTS**

### **2.01 PRODUCTS**

- A. **Manufacturer's Recommendation:** While installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendation prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish the recommendations shall be cause of rejection of the equipment or material.
- B. **Material:** Provide equipment and material of sizes, capacities, power ratings and dimensions as indicated on the Contract Drawings and in drawing schedules.
- C. **Structural:** Hot dipped galvanize all structural and miscellaneous steel used in connection with electrical work and located out-of-doors or in damp locations, unless otherwise specified. Included are underground steel pull box covers and similar electrical items. Galvanizing shall average 2.0 ounce per square foot and shall conform to ASTM A123.
- D. **Approval:** Approval of materials and equipment will be based on the manufacturer's printed data. The label or listing of Underwriter's Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this listing, submit a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures of the Underwriter's Laboratories, Inc., and that the materials and equipment comply with all Contract requirements. A manufacturer's statement indicating complete compliance with the applicable Federal Specification or Standard of the American Society for Testing and Materials, National Electrical Manufacturers Association or other Commercial Standards, will be acceptable proof of such compliance.
- E. **Conformation:** Materials and equipment shall conform to respective publications and any other requirements specified below. Furnish all materials. Materials and equipment, to be acceptable, must comply with all contract requirements. Materials to be furnished under this specification shall be of manufacturers regularly engaged in the production of such material and of the manufacturer's latest designs that comply with the specification requirements.

### **2.02 SUPPORT FOR ELECTRICAL EQUIPMENT**

- A. **Channel and Angle Supports, Raceway Supports, Sleeves and Fasteners:** As specified in Section 26 05 29.

### **2.03 MANUFACTURER'S STANDARD PRODUCTS:**

- A. **Use colors prescribed by ANSI A13.1, NFPA 70 latest edition.**

## **PART 3 - EXECUTION**

### **3.01 EQUIPMENT INSTALLATION REQUIREMENTS**

- A. **All materials and equipment shall be installed in accordance with the Contract Drawings, and with FAA-C-1217, and FAA-STD-019.**

- B. Coordinate electrical work with that of other trades so that:
  - 1. Interference between electrical and other specialty trades is to be avoided.
  - 2. Maintain clearances and advise other trades of clearance requirements for operation, repair, removal and testing of electrical equipment.
  - 3. All electrical materials and equipment shall be kept as close as possible to ceilings, walls and columns to occupy the minimum amount of space.
  - 4. Furnish and install all offsets, fittings and similar items necessary to accomplish the requirements of coordination without additional expense.
  - 5. Equipment required to be temporarily disconnected and relocated shall be carefully removed, stored, leaned, reinstalled, reconnected, and made operational.
- C. Where manufacturers recommended installation methods conflict with contract requirements, difference shall be resolved by the WRPM.
- D. The installation shall be accomplished by skilled workers regularly engaged in this type of work. Where required by local regulation, the workers shall be properly licensed.
- E. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.
- F. Install items level, plumb, parallel, and/or perpendicular to other building systems and components, except where otherwise indicated.
- G. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- H. Maintain the waterproof integrity of raceway penetrations through the roof, exterior walls, and floors.
- I. The drawings indicate certain information pertaining to surface and subsurface obstructions that has been taken from available site drawings. Such information is not guaranteed as to accuracy of location or completeness.
- J. Electrical Equipment installation shall comply with Earthquake requirements as specified in International Building Code (IBC), Section 1613 which refers to American Society of Civil Engineers, ASCE 7-05.

### 3.02 INSTALLATION

- A. Contract Drawings: Where the Contract Drawings schematically indicate the work, diagrammatically or electrically, ensure that the electrical and communications work is coordinated and compatible with Architectural, Mechanical and Structural work.
- B. Support and Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure in accordance with Section 26 05 29.
- C. Identification Devices: Install identification devices where required in accordance with the requirements of Section 26 05 53.
- D. Wiring Methods:
  - 1. General: All wiring shall consist of insulated copper conductors installed in metallic raceways unless otherwise specified.



2. Conductor routing: Panelboards, surge arresters, disconnect switches, etc., shall not be used as raceway for conductor routing other than conductors that originate or terminate in these enclosures. Isolated ground conductors will be allowed to traverse these enclosures:
3. Conductor separation: Power conductors shall be routed separately from all other conductor types. Route power conductors and other conductors in separate raceways, or use a metallic divider between the power conductors and any other conductors in the same raceway, in these enclosures. Isolated ground conductors will be allowed to traverse these enclosures.
  - a. Power cables of less than 1,000 volts may be installed in the same duct.
  - b. Power cables of less than 1,000 volts shall not be installed in the same duct with control, telephone, or signal type cables.
4. Neutral conductor: Shared/common neutrals shall not be permitted, i.e., each branch circuit shall have its own separate neutral conductor. Neutral conductor sizes shall not be less than the respective feeder or phase conductor sizes.
5. Raceway Openings: All raceway openings through floors shall be both airtight and watertight.
6. Weather Protection: Seal equipment or components exposed to the weather and make watertight and rodent proof. Protect equipment outlet and raceway openings with temporary plugs or caps at all times work is not in progress.

### 3.03 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved. Repair disturbed surfaces to match adjacent undisturbed surfaces.

### 3.04 TESTING

- A. General: Unless otherwise indicated, furnish all test instruments, materials and labor necessary to perform tests designated in other Sections of this Division.
- B. Calibration: All tests shall be performed in the presence of the WRPM. All instruments shall have been calibrated within a period of two years preceding testing. Calibrations shall be traceable to applicable industry recognized standards.
  1. Tests:
    - a. An interim operating and performance test shall be performed for each major equipment item after installation is complete and before the item is placed in service.
    - b. After mechanical systems have been completely installed and balanced, test each system for proper operation.
    - c. Tests shall be conducted in the presence of the WRPM under design conditions to ensure proper sequence and operation throughout the range of operation.
    - d. Make adjustments as required to ensure proper functioning of the systems.
    - e. Special tests on individual systems are specified under individual sections.
    - f. Provide 5 days written notice to the WRPM for major tests. Demonstrate, to the WRPM's satisfaction, proper operation of control devices by simulating actual operating conditions.
    - g. Devices tested shall include, but not be limited to, flow and pressure controls, temperature controls, and system interlocks and alarms.
    - h. Perform the tests specified and other tests necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each system.

- i. Repair or replace equipment that does not meet test requirements and retest. Notify the WRPM in writing 5 days prior to conducting tests.
- C. Instructions: After final tests and adjustments have been completed, fully instruct the WRPM and other personnel as directed by the WRPM in details of operation and maintenance of electrical equipment.
- D. Underground Cable Test: Test in accordance with FAA-C-1391. Testing of GFM cable shall be performed before and after installation.

### 3.05 DELIVERY, STORAGE AND HANDLING

- A. Clean and wipe the interior of Raceway, pullboxes and panelboards before proceeding with the wiring.
- B. Do not install damaged, broken or marred material or products, replace them with new.
- C. On long-lead delivery items which are damaged in shipping or storage, field repair may be authorized instead of replacement. Repair authorization must be in writing.

### 3.06 FIELD QUALITY CONTROL

- A. Restoration of Finish: All marred or damaged surfaces, except exposed metal for grounding purposes, shall be refinished to leave a smooth, uniform finish at final inspection. Paint to match existing.
- B. Repair of Existing Work: Where cutting, channeling, or drilling of floors, walls, or other surfaces is necessary for the proper installation, support or anchorage of the raceway, raceways, or other electrical work, it shall be carefully done. Repair with equal material by skilled workers, any damage to facilities caused by workers or equipment. Prior WRPM approval must be obtained for the materials, workers, time of day or night, repair method and for temporary or permanent repair purposes.

On completion, repair work shall be inspected and accepted by the WRPM with the concurrence of any other affected parties such as Utility Companies and Airport Authority.

- C. Damage: Where raceway and wiring to remain are inadvertently damaged or disturbed, cut out and remove portion and all damaged wiring from the source panelboard, disconnect switch or pull box to the load/destination point. Provide new wiring of equal capacity.

**END OF SECTION**

**SECTION 26 05 05****SELECTIVE DEMOLITION FOR ELECTRICAL****PART 1 - GENERAL****1.01 SUMMARY**

- A. This section includes Demolition and Removal, and/or relocation and extension, of electrical installations and facilities as indicated on Contract Drawings.

**PART 2 - PRODUCTS**

**Not Used.**

**PART 3 - EXECUTION****3.01 EXAMINATION**

- A. Verify that field measurements and circuiting arrangements are as shown on drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition is based on limited field observation and existing record documents. Report discrepancies to WRPM before disturbing the existing installation.
- D. Commencement of demolition signifies acceptance of existing conditions.

**3.02 PREPARATION**

- A. Coordinate service outages with FAA through the WRPM.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction, as required.
- C. Work performed on energized equipment or circuits shall be accomplished by personnel experienced in such operations in coordination with WRPM.

**3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL SYSTEMS**

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove all abandoned wiring to source of supply. No wiring may be abandoned in-place unless otherwise noted on Contract Drawings.
- C. Remove exposed abandoned raceway.

- D. Disconnect and remove abandoned panelboards and distribution equipment.
- E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- H. Extend existing installations using materials and methods as specified.
- I. Equipment specified or indicated to be demolished shall be removed from the project site and shall not be reused unless authorized by the Subcontract Administrator in writing.

#### 3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.

#### 3.05 INSTALLATION

- A. Provide temporary construction power as required for this project.

**END OF SECTION**

**SECTION 26 05 19**  
**LOW VOLTAGE CABLES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes building wires and cables and associated splices, connectors, and terminations for wiring systems rated 1,000 volts and less.
- B. Work must include:
  - 1. Wire
  - 2. Multi-Conductor Cable
  - 3. Wire Connections and Terminations
  - 4. Ground Wire

**1.02 REFERENCE STANDARDS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications listed below are referenced as the latest edition published as of the date of this document. The publications are referred to within the text by the basic designation only.
  - 1. National Electrical Manufacturers Association (NEMA)
    - a. WC70-00 Non-Shielded Power Cable 2000V or Less
    - b. WC26-00 Binational Wire and Cable Packaging Standard
  - 2. Federal Aviation Administration (FAA)
    - a. FAA-C-1391 Installation, Termination, Splicing, and Transient/Surge Protection of Underground Electrical Distribution System Power Cables, latest edition
    - b. FAA-C-1217 Electrical Work, Premises Wiring, latest edition
    - c. FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment, latest edition
  - 3. Federal Specification (FS)
    - a. W-S-610 Splice Connectors
    - b. QQ-W-343 Wire, Electrical, Copper, Uninsulated
  - 4. National Electrical Contractors Association (NECA)
    - a. 1-2000 Standard of Installation
  - 5. International Electrical Testing Association (NETA)

- a.     ATS                   Acceptance Testing Specification for Electric Power Distribution Equipment and Systems
  - 6.     National Fire Protection Association (NFPA)
    - a.     70                    National Electrical Code (NEC), latest edition
  - 7.     Occupational Safety and Health Administration (OSHA)
    - a.     29CFR1910.7       Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
  - 8.     Underwriters Laboratories (UL)
    - a.     83                   Thermoplastic-Insulated Wires and Cables
    - b.     486A                Wire Connectors and Soldering Lugs for Use with Copper Conductors
    - c.     486C                Standard for Splicing Wire Connectors
  - 9.     American Society for Testing and Materials (ASTM)
    - a.     B3                   Standard Specification for Soft or Annealed Copper Wire
    - b.     B8                   Standard Specification for Concentric-Lay Standard Copper Conductors, Hard, Medium Hard or Soft
    - c.     D753                Standard Specification for General Purpose Polychloroprene Jacket for Wire and Cable
  - 10.    Institute of Electrical and Electronic Engineers (IEEE)
    - a.     241                  Recommended Practice for Electric Power Systems in Commercial Buildings
  - 11.    Insulated Cable Engineers Association (ICEA)
    - a.     S-95-658           Nonshielded 0-2kV Cables
    - b.     S-105-692          600V Single Layer Thermoset Insulated Utility Underground Distribution Cable
- 1.03    SUBMITTALS
- A.     Parsons WRPM approval is required for all submittals. Submit the following:
    - 1.     Product Data: Submit product data for each product specified.
    - 2.     Specifications: Submit manufacturer's data on electric wire, cables, conductors, connectors, and connector crimping tools where specified.
    - 3.     Field Test Reports: Submit field test reports indicating and interpreting test results relative to compliance with the performance requirements of the testing standard.
- 1.04    QUALITY CONTROL
- A.     NFPA compliance

1. Comply with NFPA 70, NEC, latest edition, for components and installation.

B. Listing and Labeling

1. Provide products specified in this Section that are listed and labeled.
  - a. The Terms "Listed and Labeled": As defined in the NEC, Article 100.
  - b. Listing and Labeling Agency Qualifications: An NRTL as defined in OSHA Regulation 1910.7.

1.05 SEQUENCING AND SCHEDULING

A. Coordination

1. Coordinate layout and installation of cable with other installations.
  - a. Revise locations and elevations from those indicated as required to suit field conditions in coordination with the WRPM.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery

1. Deliver all wire and cable products to the Project site in accordance with NEMA WC-26 and in their original packaging. Conductors with damaged insulation must not be permitted.

B. Storage

1. Store wire and cable products in a clean dry space in original containers. Protect products from weather, damaging fumes, construction debris, and traffic.

C. Handling

1. Handle wire and cable products carefully to avoid abrading, puncturing, or tearing wire and cable insulation and sheathing. Ensure that the dielectric resistance integrity of wire/cable is maintained.

**PART 2 - PRODUCTS**

2.01 GENERAL

- A. Materials procured in this Section must be in accordance with FAA-C-1217, and FAA-STD-019. Unless otherwise indicated, wiring must consist of 1,000 volt insulated, single conductor, copper conductor, installed in raceway. Conductor must bear easily readable marking along the entire length, indicating conductor size and insulation type.

2.02 WIRES AND CABLES

A. Rating

1. Provide UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3, "Applications" of this section.
- B. Insulation – Above Grade and Interior Use
1. THHN/THWN conforming to NEMA WC70. XHHW-2 conforming to NEMA WC70. Insulation for conductors must be rated at 75 degrees C.
- C. Insulation – Below Grade Use
1. Conductors in contact with the earth or routed underground in raceway must be type UF, USE, XHHW-2, RHW-2, XLP-2, or of a multi-conductor armored construction with equivalent outer insulation.
- D. Characteristics
1. All wire, raceway sizes, and ampacities are based on copper conductors, 75 degrees C insulation.
  2. Conductivity must not be less than 98 percent at 20 degrees C (68 degrees F) or resistivity greater than 1.7 microohms per centimeter.
  3. Conductors sized 12 AWG and smaller for general use must be solid. Stranded 12 AWG and smaller conductors are permitted where required for specific equipment installations. Conductors 10 AWG and larger may be stranded. Conductors 12 AWG and smaller are permitted to be stranded in applications where vibration and flexing may be encountered, and must be installed with compression fittings at appropriate ends.
- E. Size
1. Minimum power conductor size must be 12 AWG.
  2. Minimum conductor size must be 10 AWG for 120 volt circuits where circuit length (one way) exceeds 75 feet from source, and 8 AWG for 120 volt circuits where circuit length (one way) exceeds 150 feet from source.
  3. Communication/control systems wiring size must be in accordance with Manufacturer's requirements.
  4. Minimum control wire size must be 14 AWG unless otherwise noted.
- F. Color Code
1. Conductors smaller than 4 AWG must be factory color coded. Color coding must be continuous throughout the facility on each phase conductor to its point of utilization so that the conductor phase connection is readily identifiable. Verify and use the existing color coding system at the facility. If there is no standard color coding at the facility, conductors must be color coded as follows:

a. AC power wiring

<u>Three Phase</u>				<u>Single Phase</u>		
<u>120/208/240 Volt System</u>				<u>277 / 480 Volt System</u>		
				<u>120/208/240 Volt System</u>		
1)	Phase A	Black	Phase A	Yellow	1) Phase A	Black
2)	Phase B	Red	Phase B	Brown	2) Phase B	Red
3)	Phase C	Blue	Phase C	Orange	3) Neutral	White
4)	Neutral	White	Neutral	Gray		

b. Equipment Grounding Conductor: Green (for all systems)



c. Control Wiring

- |    |                             |        |
|----|-----------------------------|--------|
| 1) | Ungrounded conductor wiring | Violet |
| 2) | Grounded conductor wiring   | White  |

d. Control Cables must be color coded in accordance with IAW NEMA WC70.

G. Uninsulated Conductors

1. For uninsulated conductors refer to Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

H. Prohibited Wire Products

1. The use of non-metallic sheathed cable types NM to NMC, armored-bushed cable (BX), and armor-clad cable (AC) is prohibited.

I. Control Cable

1. Control cable must be in accordance with Section 3.1. of FAA-C-1391, and with Rural Utilities Service 7 CFR 1755.390 (REA PE-39). This cable must have a core consisting of 19 gauge size (AWG) solid copper conductors with thermoplastic or thermosetting insulation color-coded per telephone industry standards. The core must be completely filled with ETPR compound. The outer sheath must have a corrugated copper or aluminum shield applied longitudinally around core. The outside jacket must be black polyethylene. It must be a standard product of a major cable manufacturer, and must be rated for outdoor, direct-earth burial use.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine raceways that are to receive wires and cables for compliance with installation tolerances and other conditions. Verify that the duct or raceway is open, continuous, and clear of debris before installing cable. Do not proceed with installation until unsatisfactory conditions have been corrected.

### **3.02 APPLICATIONS**

A. Grounded Conductors

1. In single-phase systems (120 volt two-wire and 120/240 volt three-wire), one grounded conductor (neutral) must accompany each ungrounded phase conductor (120 volt systems) or ungrounded phase conductor pair (120/240 volt systems) powered from a circuit-interrupting device. In three-phase (Y-connected, 4-wire) systems, one grounded neutral conductor must accompany the three related ungrounded conductors fed from a circuit interrupting device. All neutral conductors must extend from the neutral bus in the power source. Device terminals for connection of more than one conductor must be specifically designed for that purpose.

B. Bundling

1. Where more than one circuit 10 AWG and smaller (ungrounded, grounded, and grounding conductor) enters a branch circuit panelboard or pull box from the same raceway, neatly and securely bundle each circuit so that it is identifiable. Wire ties or electrical tape may be used.

**C. Conductors and Cables**

1. Materials installed in this Section must be in accordance with FAA-C-1217, FAA-C-1391, and FAA-STD-019.
2. Install wires and cables as indicated, according to manufacturer's written instructions and the NECA "Standard of Installation." Tag all conductors at their termination in accordance with Section 26 05 53, IDENTIFICATION FOR ELECTRICAL SYSTEMS.
3. Pull conductors into raceway simultaneously when more than one is being installed in the same raceway.
  - a. Use wire pulling compound or lubricant as required. Compound used must not deteriorate the conductor or insulation, and must be non-flammable.
  - b. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage the cables or raceway.
4. Cable must be installed in a manner to prevent harmful stretching of the conductor, injury to the insulation, or damage to the outer protective covering.
5. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
6. The ends of cables must be sealed with moisture-seal tape before pulling, and must be left sealed until connections are made.

**D. Conductor Splices**

1. Splices must be made at outlets, junction boxes, pull boxes, manholes/handholes, or accessible raceways only. Splice 1,000V conductors in pull boxes only. Splices must be made in manholes/handholes as indicated on the drawings only. All other splices within manholes/handholes must require written approval.
2. Splices must be made with solderless connectors conforming to FS W-S-610, UL-486A, UL-486C, and UL-486E.
3. Wire nuts may only be used to splice conductors sized 10 AWG and smaller.
4. Compression connectors must be used to splice conductors 8 AWG and larger. Use proper tool to provide circumferential pressure connection.
5. All splices, including those made with insulated wire nuts, must be insulated with electrical tape or heat-shrink tubing to a level equal to that of the factory insulated conductors.
6. Splicing of ungrounded conductors in panelboards is not permitted.
7. Install splices and insulating tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
8. Use splice and tap connectors that are compatible with conductor material.
9. Splicing methods and material must be of a type recommended by the manufacturer of the splicing material for the particular type of cable being spliced, and must be approved by the RE prior to installation.
10. Conductors of different color insulation must never be spliced together.
11. Keep conductor splices to a minimum.
12. A splice must not be pulled into a duct or a raceway under any circumstances.
13. Install waterproof taps in underground structures.

**E. Conductor Identification**

1. For conductors 4 AWG and larger, color code in accordance with this Section and Section 26 05 53, IDENTIFICATION FOR ELECTRICAL SYSTEMS.

- a. All line, phase, and neutral conductors must have their source and circuit labeled.
- b. Conductor identification must be provided at all terminations, in all junction boxes through which these conductors pass, and within each enclosure where a splice, tap, or termination is made.
- c. Terminal and conductor identification must match at both ends of the run, as on approved shop drawings.

F. Wiring at Outlets

1. Install with at least 12 inches of slack conductor at each outlet for connection to equipment. Identify all conductor circuit numbers at terminals and junction points.

G. Connections at Outlets

1. Connect outlets and components to wiring and to ground as indicated on shop drawings. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

H. Large Conductors

1. Cables/conductors sizes 250 kcmil and greater must be installed with the use of a hydraulic cable bender where installed exposed (e.g. manholes). Cable supports must be required for stress relief.

I. Grounding

1. Grounding must be installed in accordance with Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

J. Shared Neutrals and Grounds

1. Separate neutral and ground wires must be provided for each overcurrent protection device. Shared/common neutrals are not allowed. Install a separate neutral wire per phase for all lighting and power outlet circuits.

K. Termination

1. Provide compression type termination lugs where mechanical lugs included with equipment do not comply with FAA STD-1217.

L. Phasing

1. The phasing of the complete electrical installation must be connected and consistently maintained throughout the power distribution system. The phasing must be "A, B, C, from front to back, top to bottom, or left to right, as viewed from the front of the switchboard, switchgear, or panelboard".

M. Conductor Supports

1. Provide conductor supports as required by the NEC and recommended by the cable manufacturer. Where required, route vertical conductor runs in raceway.

N. Conductors and Slack

1. Provide all conductors and connectors necessary for a complete installation from the point of service connections to all devices shown on the drawings, in schedules, and in the specifications. Provide ample slack wire for all connections.

### 3.03 FIELD QUALITY CONTROL

#### A. Testing, General

1. Cables must be tested prior to installation and again upon completion of the installation. Testing must also be performed prior to termination. Tests must be performed in the presence of the WRPM.
  - a. Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
  - b. Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.1. Certify compliance with test parameters.
  - c. Test wire and cable for continuity of circuitry, proper phasing, and also for short circuits.

#### B. Insulation Resistance Tests

1. Feeder and Branch Circuit insulation tests must be performed after installation, but before connection to equipment.
  - a. Conductors must test free from short circuits and grounds, and have a minimum phase-to-phase and phase-to-ground insulation resistance of 30 megohms when measured with a 500-volt DC insulation resistance tester. Submit a letter type test report to the WRPM prior to final inspection of the Work. The report must list the tests performed and results obtained.
  - b. Apply the test voltage for at least one minute after motor reading has stabilized.
  - c. Use "FAA megger form" located at the end of this Section to record megger readings.

#### C. Corrections

1. Correct malfunctioning products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

**FAA MEGGER FORM**  
**Field Test Record Megger Readings**  
**(Power and Control Wire/Cable)**

Project Name \_\_\_\_\_ Date \_\_\_\_\_ Sheet No. \_\_\_\_ of \_\_\_\_  
Project No. \_\_\_\_\_ Address \_\_\_\_\_

NOTE: MEGGER ALL PHASES, RECORD MINIMUM READING.

Panel No. Ckt. No. Feeder No.	WIRE TAGGING	VOLT.	WIRE OR CABLE				MEGOHMS	SUPERVISOR O.K.
			NO.	SIZE	FROM	TO		

DISTRIBUTION: WRPM

PM  
File

\_\_\_\_\_  
WRPM / Date

\_\_\_\_\_  
Supervisor / Date

**END OF SECTION**

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**SECTION 26 05 26****GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes furnishing material, equipment and labor necessary to install a complete grounding system for the protection of life and equipment from lightning and power faults, and for minimizing electromagnetic interface. Grounding requirements specified in this Section may be supplemented by requirements in other Sections of these Specifications. Work shall include the following systems:
1. Power System Grounding
  2. Electrical and Electronic Equipment Grounding
  3. Raceway Grounding and Bonding
  4. Multipoint Grounding

**1.02 REFERENCE STANDARDS**

- A. Applicable only to the extent specified
1. American National Standards Institute (ANSI)
    - a. C62.41 Recommended Practices on Surge Voltages in Low-Voltage AC Power Circuits
  2. American Society for Testing and Materials (ASTM)
    - a. B3 Soft or Annealed Copper Wire
    - b. B8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft
    - c. B33 Tinned Soft or Annealed Copper Wire for Electrical Purposes
  3. Federal Aviation Administration (FAA)
    - a. FAA-C-1217 Electrical Work, Interior, latest edition
    - b. FAA-C-1391 Installation, Termination, Splicing, and Transient/Surge Protection of Underground Electrical Distribution System Power Cables, latest edition
    - c. FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment, latest edition
    - d. FAA-STD-020 Transient Protection, Grounding, Bonding, and Shielding Requirements for Electrical Equipment
  4. Institute of Electrical and Electronic Engineers (IEEE)

- a. 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
  - b. 1100 Powering and grounding sensitive electronic equipment
- 5. National Fire Protection Association (NFPA)
  - a. 70 National Electrical Code (NEC), latest edition
  - b. 77 Static Electricity, latest edition
  - c. 780 Lightning Protection Code, latest edition
- 6. Occupational Safety and Health Administration (OSHA)
  - a. 29CFR1910.7 Definitions and Requirements for Nationally Recognized Testing Laboratories (NRTL)
- 7. Underwriters Laboratories (UL)
  - a. 96 Lightning Protection Components
  - b. 96A Installation Requirements for Lightning Protection Systems
  - c. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
  - d. 467 Grounding and Bonding Equipment

#### 1.03 ACTION SUBMITTALS

- A. Parsons WRPM approval is required for all submittals.
  - 1. Product Data for grounding rods, connectors and connection materials, and grounding fittings.
  - 2. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
  - 3. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.
  - 4. Surge and Transient Protection Requirements.

#### 1.04 QUALITY CONTROL

- A. Testing Agency Qualifications:
  - 1. An NRTL as defined in OSHA Regulation 1910.7, or a full member company of NETA.
    - a. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
  - 2. Comply with FAA specification C-1217, C-1391, and FAA-STD-019.
  - 3. Comply with NFPA 70, National Electrical Code, latest edition.
  - 4. Comply with UL 467.
  - 5. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
    - a. The terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.



- b. Listing and labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

## **PART 2 - PRODUCTS**

### **2.01 GROUNDING AND BONDING PRODUCTS**

- A. All types indicated and all sizes and ratings to comply with FAA C-1217, FAA-C-1391, and FAA-STD-019. Where types, sizes, ratings and quantities indicated are in excess of requirements above, the more stringent requirements and the greater size, rating, and quantity indications shall govern.

### **2.02 EARTH ELECTRODE SYSTEM (EES) (COUNTERPOISE)**

- A. Grounding Electrode Conductor: The grounding electrode conductor shall be insulated green copper and shall be sized and indicated as shown on the contract documents.
- B. Ground Rods: Ground Rods shall be 3/4 inch diameter by 10 feet copper or copper-clad steel. Sectionalized type or exothermic butt welded rods shall be provided when deeper earth penetration is required. Ground rods shall bear the manufacturer's name, trademark and catalog number.
- C. Access Wells: Access wells shall be pre-cast concrete, and have a removable cover. The access well shall have a minimum interior measurement of 24 inches circular clearance, and be of sufficient size to allow ground rod connections to be readily accessible for testing and maintenance. All connections shall be made by the exothermic weld process.

### **2.03 WIRE AND CABLE GROUNDING CONDUCTORS**

- A. Comply with Section 26 05 19 LOW-VOLTAGE CABLES.
- B. Conform to NEC Table 8 "Conductor Properties," except as otherwise indicated on Contract Drawings.
  - 1. Material: Use only copper wire for both insulated and bare for grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials. Conform conductors to the following:
    - a. Solid Conductors: ASTM B3
    - b. Assembly of Stranded Conductors: ASTM B8
    - c. Tinned Conductors: ASTM B33
    - d. Size: Size bare ground conductors in accordance with latest edition of NEC and FAA-STD-019. Minimum allowable size of #2 AWG for ground conductors in contact with earth.
- C. Equipment Grounding Conductors:
  - 1. Copper conductor with green color insulation.
  - 2. Size: Size equipment grounding conductors per Table 250.122 of the NEC, latest edition.
- D. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.

- E. Grounding Electrode Conductor (GEC):
  - 1. Copper conductor with green insulation.

#### 2.04 MISCELLANEOUS CONDUCTORS

- A. Raceway Bonding Jumpers: Copper, minimum size #6 AWG above grade, #2 AWG below grade.
- B. Guard Cable: #1/0 AWG, 7 strand, bare copper cable.
- C. EES (Counterpoise) Cable: Minimum #4/0 AWG, 7 strand, bare copper cable.

#### 2.05 CONNECTOR PRODUCTS

- A. Exothermic Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items. All underground conductor-to-conductor connections and conductor to ground rod connections shall be made by the exothermic weld process, unless otherwise noted. For certain materials and shapes which exothermic welds may not be possible, coordinate connection method with WRPM.
  - 1. Substitutes: Provide exothermic connections equal to Cadweld. To substitute another exothermic weld process, submit a chemical analysis by an independent test laboratory certifying:
    - a. The material used contains no phosphorous, caustic, toxic or explosive substance.
    - b. Weld material used for ground connections contains copper oxide, aluminum and not less than 3% tin as a wetting agent. Weld metal for cathodic connections shall contain vanadium, but no tin.
    - c. A minimum of 80 percent of the weld metal shall screen out between 30 and 140 Mesh.
    - d. Exothermic Weld shall meet the applicable requirements of IEEE-80, Chapter 9, Section of Conductors and Joints.
    - e. Molds shall be made from graphite or other material withstanding welding temperatures and shall be designed to provide average life of not less than 50 exothermic welds under normal conditions. The molds shall bear permanent marking, indicating the name of the manufacturer, the mold model, the type, and size of the welding mixture compatible with the welding process and the size of the conductor. Instructions detailing general safety information, welding procedures shall be provided with each mold. The installer is prohibited from using a mold from one manufacturer with a different manufacturer's welding mixture.
  - 2. Application: Exothermic connections to be used outdoors shall be suitable for exposure to the elements and direct burial without degradation over the grounding system.

### PART 3 - EXECUTION

#### 3.01 APPLICATION

- A. Grounding:

1. Installation of FAA grounding requirements often exceed those of NEC; therefore, install grounding system as indicated in Contract Drawings, and as specified herein. Reference IEEE-1100-1992, "Recommended Practice for Powering and Grounding Sensitive Electronic Equipment", when installing equipment. In no case shall the NEC be violated.
2. Under no circumstances shall the equipment grounding conductor be omitted from the electrical system, nor shall any separate grounding system such as electrical signal ground or direct connections to the Earth Electrode System be used for an alternate grounding system or an alternate path to the grounding electrode conductor.
3. All ground connections to equipment shall be made with a ground connector specifically intended for that purpose.
4. Separately Derived Systems: Where NEC requires grounding, Ground according to FAA-STD-019.
5. Equipment grounding conductor shall be connected to the grounded conductor (neutral) only at the service disconnecting means and at separately derived systems. This connection is sometimes called the "Main Bonding Jumper."

### 3.02 INSTALLATION:

#### A. Install grounding systems in accordance with latest edition of:

1. FAA-C-1217
2. FAA-C-1391
3. FAA-STD-019
4. NFPA 70
5. Local codes

#### B. Service Entrance Grounding:

1. At the service entrance equipment, bond the service neutral, building neutral and building ground conductor to a common ground bus (or lug). Connect the ground bus (or lug) to the counterpoise grounding system with the grounding electrode conductor. All connections at the service shall be made on ground buses (or lugs). Split bolts or cable clamps are not allowed to for this connection.

#### C. Grounding Electrode Conductor:

1. This conductor shall be connected to the neutral bus in the service disconnecting means and shall extend directly to a ground rod in the grounding electrode system in one continuous un-spliced run. The grounding electrode conductor shall be insulated with green insulation and sized as shown in the Contract Drawings. When not indicated in the contract documents, the conductor shall be sized in accordance with NEC Table 250-66 "Grounding Electrode Conductor for AC Systems," except that the conductor shall not be smaller than #2 AWG per FAA-STD-019. All grounding electrode conductors, except for those at the outdoor utility transformers, shall be routed in PVC raceway. Where the grounding electrode conductor is routed through a metal raceway, the raceway shall be electrically continuous and bonded to the conductor at each end with a solid copper conductor welded to the raceway. The grounding electrode conductor shall be connected to the Earth Electrode System by exothermic means. Make connections readily accessible for inspection. For a separately derived system such as an isolation transformer, the grounding electrode conductor shall be connected in accordance with the NEC.

#### D. Grounded Conductor (Neutral):

1. Shared/common neutrals (grounded conductor) shall not be permitted, i.e., each branch circuit shall have its separate grounded conductor. Grounded conductors shall be sized in accordance with NEC Article 250.

**E. Earth Electrode System (Counterpoise):**

1. Unless otherwise indicated on Contract Drawings, the grounding electrode system shall consist of a minimum of four (4) ground rods located at each corner of the structure.
  - a. Ground rods shall be interconnected by a buried, bare, #4/0 AWG, 7 stranded copper cable. The ground cable shall be directly buried at least 2'-6" below grade level. The interconnecting cable shall close on itself, forming a complete loop, with the ends exothermically welded. Provide sufficient mechanical protection during installation so as not to break cable or connections.
  - b. Connect structural steel of buildings to the earth electrode system with a bare, #4/0 AWG cable.
  - c. All underground metallic pipes, metallic raceway, tanks, and telephone ground shall be connected to the earth electrode system by a copper cable no smaller than #2 AWG. Exothermic welds shall not be used where hazards exist, i.e. near fuel tanks. In these cases, pressure connectors will be allowed as approved by WRPM.
  - d. All exposed non-current carrying metallic parts of electrical and mechanical equipment including metallic raceway systems, piping, steel columns and structural members and neutral conductors of the wiring systems shall be grounded as required by the latest edition of NEC and FAA-STD-019.
  - e. Install ground cables in Schedule 80 PVC raceway where routed above grade, unless otherwise indicated on Contract Drawings.
  - f. Guard Wire: Install guard wire in trench lines where protecting PVC or direct buried cables. Locate guard wire 10 inches (minimum) above the raceway/cable. Connect guard wire to ground rods and the earthen electrode system by exothermic means. Space ground rods at approximately 90-foot intervals along the trench line. Locate ground rods 2 feet outside of trench/handhole wall.
  - g. Ground pad-mounted equipment and non-current-carrying metal items by connecting them to Earth Electrode System by exothermic means.
  - h. Ground Rods: Install ground rods as follows:
    - 1) Spacing: Ground rods shall be as widely spaced as practical, and shall not be spaced less than one rod length apart. Spacing between rods around structures should be between 10 to 30 feet, nominal 20 feet, as shown on Contract Drawings.
    - 2) Depth of rods: Tops of vertically-driven ground rods shall be not less than 12 inches below frost line.
    - 3) Location: Ground rods shall be located 2 to 6 feet outside the foundation or exterior footing of the structure.
    - 4) Manholes and Handholes: Install a copper ground bus in each handhole/manhole. Install driven ground rods 2 feet from outside wall of handhole/manhole. Install a #2 AWG bare conductor from ground bus inside the manhole/handhole through a waterproof sleeve in manhole/handhole wall, and exothermically weld to the ground rod.
    - 5) Access Wells: Install where indicated on contract drawings. Set top of well flush with finished grade or floor. Place gravel in well to a level 3 inches below ground rod connections.

**F. Equipment Grounding Conductors:**

1. All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings.
  - a. Size: equipment grounding conductors in accordance with Table 250-122 of the NEC, "Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment." Where ungrounded conductors are increased in size to compensate for voltage drop, the equipment grounding conductors shall be increased in size proportionately per the NEC. Minimum size shall be #12 AWG.
  - b. Install equipment ground conductors in the same raceway as its related feeder and branch circuit conductors. Connect this conductor to the ground bus in the panelboard.
  - c. Sharing of equipment ground conductors between circuits is not permitted. Each overcurrent protection device shall have its own separate equipment grounding conductor.
  - d. Metal raceway housing the equipment ground conductors shall be electrically continuous forming a parallel path to the equipment ground conductor.
  - e. All connections to equipment to be grounded shall be made with a grounding connector specifically intended for that purpose.
  - f. Bare wire wrapped around connecting screws or mounting bolts and screws, is not acceptable as a ground connection. All ground lugs shall be of a non-corrosive material suitable for use as a ground connection and must be compatible with the type of metal being grounded. Ground lugs shall be mounted on clean, bare metal surfaces that are free of paint, rust, etc.
  - g. Raceway or cable shields shall not be used as the equipment ground conductor.

**G. Raceway**

1. All metal raceways shall be grounded as follows:
  - a. All joints between raceway sections and between raceway, fittings and boxes shall be electrically continuous. All pipe and lockout threads shall be treated with a conductive lubricant prior to assembly. Joints that are not otherwise electrically continuous shall be bonded with short jumpers of #12 AWG or larger copper wire. The jumpers shall be welded or brazed in place or shall be attached with clamps, split bolts, grounding bushings or other devices approved for the purpose. All bonds shall be protected against corrosion. Cover plates of raceway fittings, pull boxes, junction boxes and other outlet boxes shall be grounded by securely tightening all available screws.
  - b. Every component of metallic raceway runs such as individual sections, couplings, line fittings, pull boxes, junction boxes and outlet boxes shall be bonded, either directly or indirectly, to the ground system or facility steel. Raceway brackets and hangers shall be securely bonded to the raceway and to the metal structure to which they are attached

**H. Equipment Enclosure Grounding:**

1. Ground all enclosures (panels, boxes, cabinets, etc.) of electrical and electronic wiring distribution equipment with approved ground lugs in accordance with the NEC.

**I. Sleeves:**

1. Where ground cables pass through slabs, buildings etc., and when not in metallic enclosures, provide a PVC raceway sleeve.

**J. Electronic Multipoint Ground System:**

1. Color shall be green with bright orange tracer. Where cables are concealed and not color-coded, any exposed portion of the cable and each end of the cable for a minimum of 2 feet shall be color coded by green tape overlaid with bright orange tape to form the tracer. Where routed through raceways or wireways, the color-coding shall be such that by removing or opening any cover, color-coding shall be visible.

K. Fault Protection:

1. Prevent equipment parts subject to human contact during installation from being electrically energized during powering faults or when components fail. Ground parts with a low impedance path to the chassis or cabinets in which they are mounted.

3.03 CONNECTIONS:

- A. Materials provided in this Section shall be in accordance with FAA-C-1217, FAA-C-1391, and FAA-STD-019.
- B. Make connections so that the possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors and connection methods so metals in direct contact will be galvanically compatible.
  1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
  2. Make connections with clean, bare metal at points of contact.
  3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
  4. Where exothermic welding cannot be used or is inappropriate, use FAA approved "U" type bronze pipe connections.
- C. Exothermic-Welded Connections: Used for connections to structural steel and for underground connections. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- D. Ground lugs and bushings: Terminate insulated equipment grounding conductors for feeders with pressure-type grounding lugs. Where metallic raceways terminate at non-metallic or non-conductive housings, terminate each raceway with a grounding bushing. Connect grounding bushings with a bare ground conductor to the grounding bus in the housing. Bond electrically non-continuous raceways at both entrances and exits with grounding bushings and bare ground conductors.
- E. Other Grounding Systems: Any additional ground systems used for electronic equipment shall be connected directly to the exterior earth electrode system. The conductor used for other ground systems shall be color coded as follows:
  1. Green with a bright orange stripe and for multipoint signal ground.
  2. Green with a bright red stripe for high-energy transient ground.
- F. Connections at Access Wells: Use exothermic welded connections between conductors and grounding rods in access wells unless otherwise indicated on Contract Drawings.
- G. Torque: Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with torque tightening values specified in UL 486A.

- H. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Mechanical connections using a Burndy “Hyground Connector” or equipment when operated at a force of 24,000 pounds are acceptable as FAA approved pressure connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on ground conductor. Hydraulically crimped connectors are not acceptable in a lightning protection system.
- I. Lug Type Connections to Equipment: Use NEMA 2-hole long barrel ground lugs with three (3) crimps. Ground lugs, connectors and other components shall comply with the NEC, latest edition.

### 3.04 BONDING REQUIREMENTS

- A. Method: At each location where raceways first penetrate a shelter or building’s exterior wall direct connections shall be made to the equipment ground.
- B. Location: Bonding straps include jumpers, shall be installed in the following locations:
  - 1. Bonding straps shall be attached to the basic member.
  - 2. Bonding straps shall be installed to be unaffected electrically by motion or vibration.
  - 3. Bonding straps shall be installed whenever possible in areas accessible for maintenance.
  - 4. The method of installation and point of attachment of bonding straps shall not weaken the members to which they are connected.
- C. Bonding Straps: Bonding straps shall not be compression-fastened through non-metallic material.

### 3.05 FIELD QUALITY CONTROL

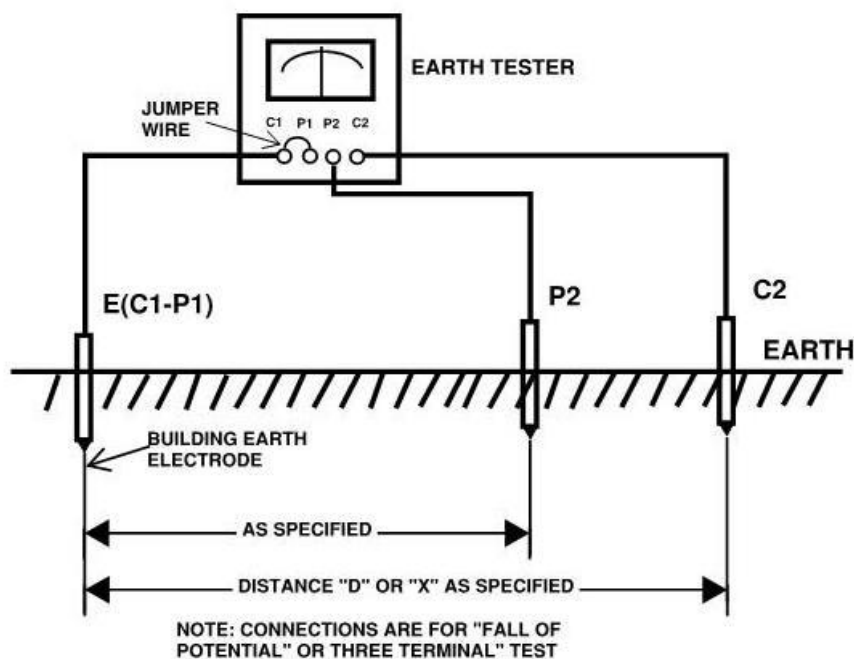
- A. Tests: Perform tests described below. Ensure no connection to utility power is made during testing.
  - 1. Fall of Potential: Subject the completed EES system to an earth resistance test using a ground test null balance megger instrument designed for the purpose, such as a Biddle, utilizing the fall of potential method (3-point). Measure ground resistance not less than 3 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
  - 2. Earth Electrode System Resistance: The resistance of the earth electrode system shall not exceed 10 Ohms unless otherwise noted.
  - 3. Bolting Resistance: Spot test to verify that ground cable bolted connections have a DC resistance of one milliohm maximum, when measured with a bridge type milliohmeter or similar instrument.
  - 4. Continuity: Test ground conductors, sheet metal, metallic raceways, cellular metal deck, equipment enclosure, metallic enclosures, and lighting fixtures for continuity to ground system with a megger.
  - 5. Bonding Resistance: Unless otherwise specified all bonds shall exhibit a resistance of one milliohm or less when measured between bonded members with a 4 terminal milliohm meter.
  - 6. Witness: Tests shall be witnessed by RE and Local FAA.
- B. Deficiencies: Where ground resistances exceed specified values, tighten connections, modify the EES system by the addition of additional ground rods, or replace faulty wiring as required until continuity/resistance conforms to the NEC requirements and the requirements of this Specification. Re-measure the continuity/resistance to verify compliance.



- C. Report: Prepare test reports, certified by the testing organization, of continuity/resistance at each test location. Include observations of weather and other phenomena that may affect test results. Submit test reports to RE.

### 3.06 EARTH ELECTRODE SYSTEM RESISTANCE TEST PROCEDURE

- A. A qualified electrician furnished by the subcontractor, must perform the following test. The following procedure is the fall of potential method (three terminal test). Connections of ground test equipment to probes and EES are shown in Figure 1.



**FIGURE – 1 FALL OF POTENTIAL TEST CONNECTIONS**

1. Sketch: Prepare a sketch utilizing contract shelter grounding plan drawings of the EES. Select a point on the EES and a direction of measurement which is away from the EES under test, and away from known underground metallic objects (water pipes, cables, etc.).
2. Connection to EES: Connect the jumpered C1-P1 lead to the EES at point E.
3. Position of current probe C2: From the Selected electrode or point E and in the chosen direction, position the current probe (C2) at a convenient distance (D) or (X) from the measurement point. Refer to Test Method "A" (REIL, PAPI and ASR) and see sample shown in Figure 2. Refer to Test Method B (ILS, ALSF, VOR, and MALSR) and see samples shown in Figure 3. (NOTE: Readings obtained for the facility ground resistance are more accurate when the spacing between E and probe C2 is maximized. The distance chosen may be limited to the area available. Vary probe spacing to avoid paved areas).
4. Position of Potential Probe P2: Refer to teste Method "A" for REIL, PAPI and ASR. Refer to test Method "B" for ILS, ALSF, VOR, and MALSR.
5. Measurements: Drive Probes 4" to 12" Deep into Earth at several points on a straight line between the measurement point (E) and Probe (C2). Measure the resistance in accordance with the instrument manufacturer's instructions. When performing these measurements the resistance read should increase to a certain point, level off, and increase again. A plot of Resistance to Earth vs. Distance may be drawn by using the values obtained as the P2 probe is moved toward or away from the C2 probe. The correct resistance to earth at the electrode



being measured at point (E) is estimated by extrapolating the curve to its asymptotic value (where curve levels off) as shown in Figure-4 for Test Method A and Figure 6 for Test Method B. This test is repeated to verify correct readings. If the curve does not level off, the current probe (C2) must be placed at an increased distance from the measurement point (E).

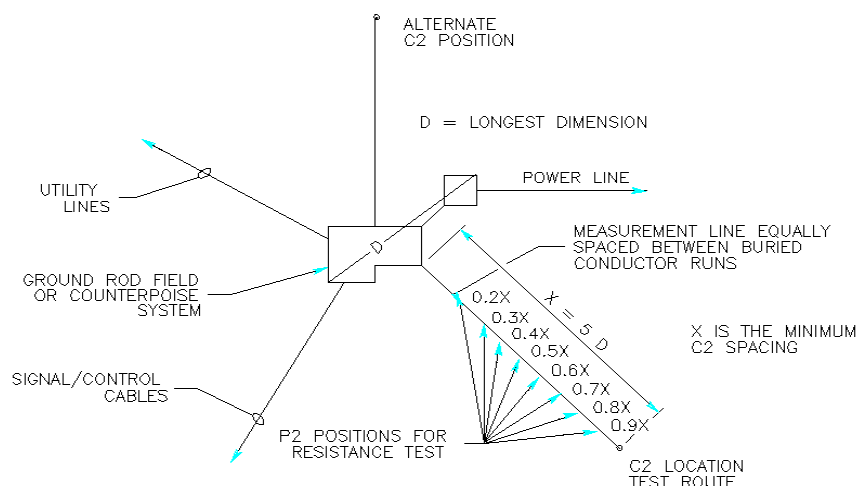
- a. Repeat the above measurements in other directions at least 60 degrees from the first line of measurement and from other earth electrodes of the earth electrode system being checked. Whenever the test probe locations are moved to other areas, there may be a difference in soil conditions which will result in a change to the resistance values at each probe position and/or the derived plot obtained.

#### 6. Test Method "A"

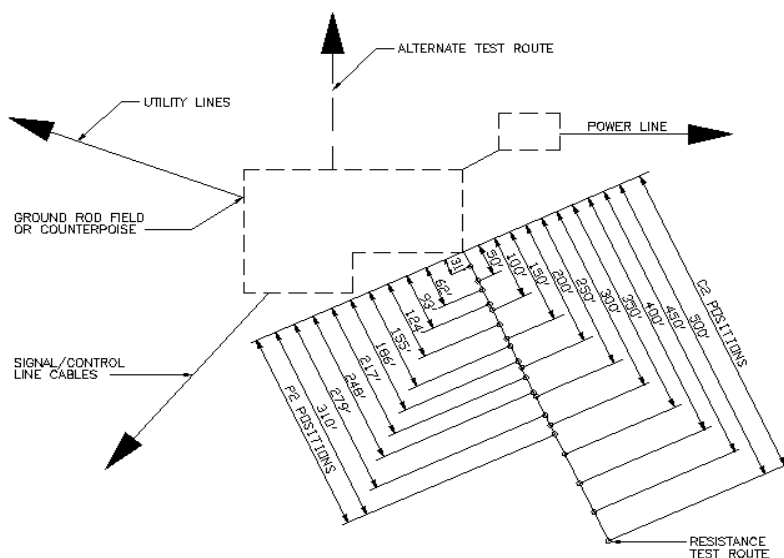
- a. Determine the maximum dimension X of the EES system. For a circle, this dimension is the diameter; for a square or rectangle, the dimension is the diagonal; for other shapes, select the longest lateral distance across the EES system as illustrated in Figure-2. Locate the current probe C2 of the earth tester at a distance equal to or greater than 5 times the dimension X. Earth testers are typically supplied with approx. 100' probe leads. For all but the simplest EES System, 100' leads are insufficient for spacing of probe C2 and potential probe P2. The 100' spacing may be used for one or two-rod systems where the rods are not more than 20' apart. Thus, in most cases, additional lead wire must be needed for connecting the test instrument to Probes C2 and P2. For distances up to 1000', number #16 AWG wire may be used. Standard lamp cord is an acceptable lead.
- b. Position the C2 Probe along a line which maximizes the distance from the electrode under test & from other buried metals such as utility pipes, power & signal cables, fuel tanks, etc. In choosing the direction for the placement of C2 probe, examine the configuration of the electrode system for the facility & determine the location of all such buried metal facilities. Then locate the probe as far as possible from all these metal facilities as illustrated in Figure-2  
Next position the Probe P2 along a straight line between probe C2 and the point of connection to the EES System under test. Record the first P2 resistance reading. Following the instructions supplied with the tester, with probe P2 located about 10% of the distance X between the EES and Probe C2, take the second reading. Repeat the measurement at 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, & 0.9 of distance X. Record the distance and the resistance measured at each P2 location on the data sheet shown in Figure-5. Figure-4 is an example of a typical worksheet that has been completed.

#### 7. Test Method "B" (Perform for ALSF, MALSR, VOR and ILS Facilities Only)

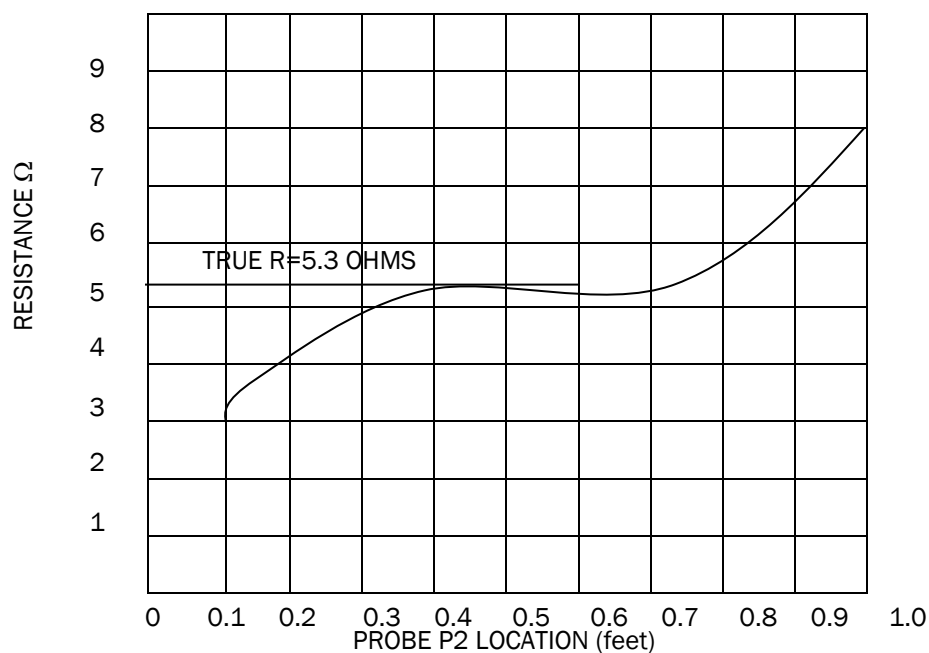
- a. Position the C2 probe along a line which maximizes the distance from the EES under test and from other buried metals such as utility pipes, power and signal cables, fuel tanks, etc. In choosing the direction for placement of the C2 probe, examine the configuration of the electrode system for the facility and determine the location of all such buried metal systems. Then locate the probe as far as possible from these metals as illustrated in Figure-3. Keep C2 and P2 leads separated as far as possible.
- b. Position the C2 and P2 probe at distances as shown in Figure-3. Record the resistance readings at each probe position in Table shown in Figure-7. (Note that the P2 positions are 62% of the C2 positions). It may not be necessary to plot the full 500 feet. Plot enough points to accurately determine where the curve levels off.
- c. Plot on a graph (Figure-7) as many recorded resistance readings versus the corresponding probe positions as necessary to determine where the curve levels off.
- d. The true value of resistance can be estimated by extrapolating the curve to its asymptotic value (where curve levels off). Refer to sample data and graph in Figure-6.



**FIGURE - 2 METHOD A TEST ROUTE (SAMPLE)**



**FIGURE - 3 METHOD B TEST ROUTE (SAMPLE)**



**EARTH RESISTANCE GRAPH (SAMPLE)**

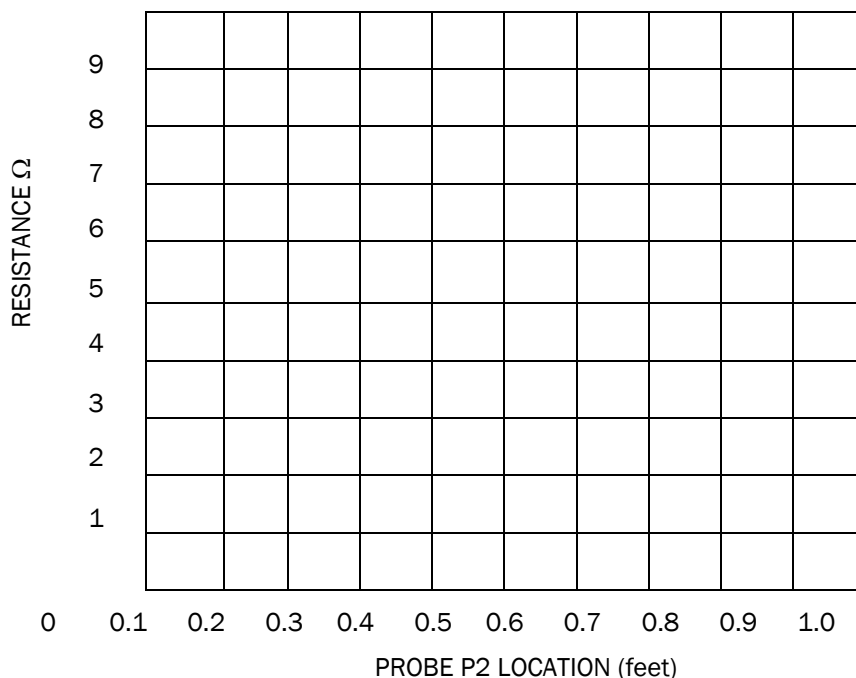
P2 PROBE LOCATION (Factor x X, X = C2 Distance)	P2 PROBE DISTANCE (Feet)	RESISTANCE METER READING ( $\Omega$ )
0.1X	26	3.2
0.2X	26	3.2
0.3X	39	4.1
0.4X	52	4.5
0.5X	65	4.5
0.6X	78	5.2
0.7X	91	5.4
0.8X	104	5.3
0.9X	117	6.3

DEPTH OF REFERENCE PROBES= 1' - 0"

$R_{\Omega}$  (REFERENCE RESISTANCE) = 5.3 OHMS

**EARTH RESISTANCE DATA TABLE (SAMPLE)**

**FIGURE - 4 METHOD A DATA TABLE AND GRAPH (SAMPLE)**



**EARTH RESISTANCE GRAPH (BLANK)**

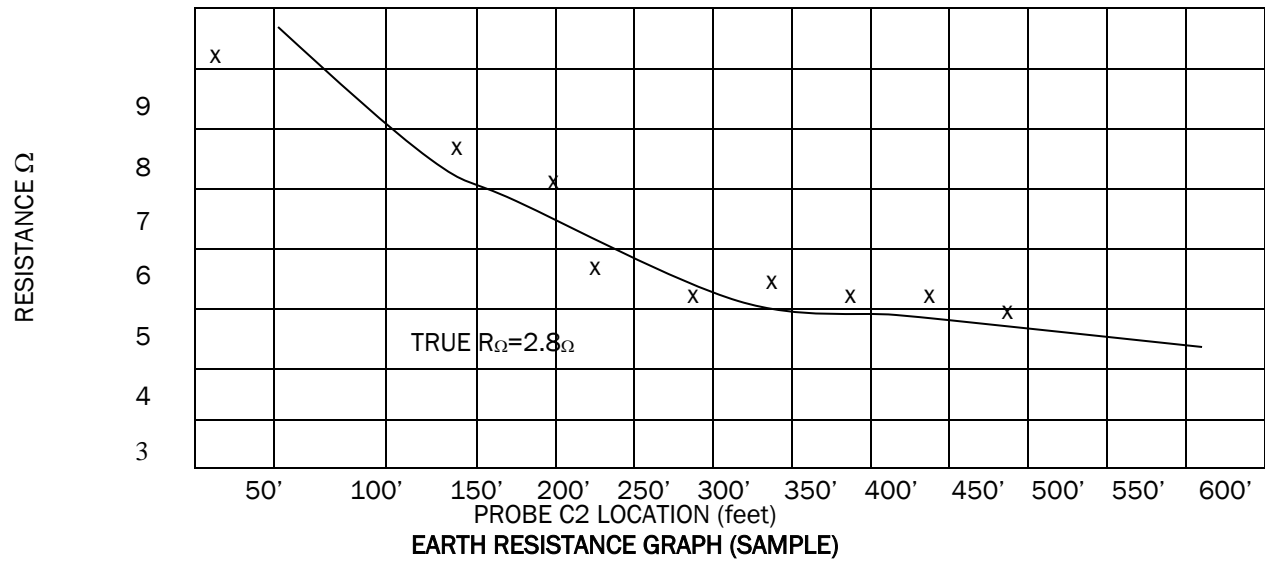
P2 PROBE LOCATION (Factor x X, X = C2 Distance)	P2 PROBE DISTANCE (Feet)	RESISTANCE METER READING ( $\Omega$ )
0.1X		
0.2X		
0.3X		
0.4X		
0.5X		
0.6X		
0.7X		
0.8X		
0.9X		

DEPTH OF REFERENCE PROBES= \_\_\_\_\_

$R_{\Omega}$  (REFERENCE RESISTANCE) = \_\_\_\_\_

**EARTH RESISTANCE DATA TABLE (BLANK)**

**FIGURE - 5 METHOD A DATA TABLE AND GRAPH (BLANK)**



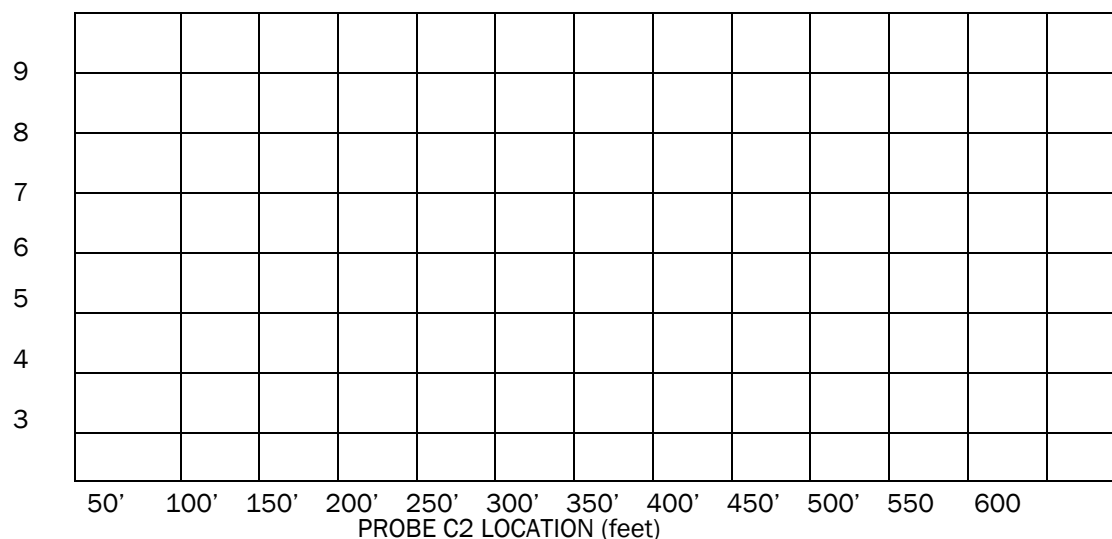
C2 PROBE DISTANCE (Feet)	P2 PROBE DISTANCE (.62 x C2) (Feet)	RESISTANCE METER READING (Ω)
50	31	7.5
100	62	5.2
150	93	5.9
200	124	5.2
250	155	4.2
300	186	3.4
350	217	3.8
400	248	3.4
450	279	3.4
500	310	3.1

DEPTH OF REFERENCE PROBES= \_\_\_\_\_

$R_{\Omega}$  (REFERENCE RESISTANCE) = \_\_\_\_\_

**EARTH RESISTANCE DATA TABLE (SAMPLE)**

**FIGURE 6: METHOD B DATA TABLE AND GRAPH (SAMPLE)**



**EARTH RESISTANCE GRAPH (BLANK)**

C2 PROBE DISTANCE (Feet)	P2 PROBE DISTANCE (.62 x C2) (Feet)	RESISTANCE METER READING ( $\Omega$ )
50		
100		
150		
200		
250		
300		
350		
400		
450		
500		

DEPTH OF REFERENCE PROBES= \_\_\_\_\_

$R_{\Omega}$  (REFERENCE RESISTANCE) = \_\_\_\_\_

**EARTH RESISTANCE DATA TABLE (BLANK)**

**FIGURE - 7 TEST METHOD B DATA TABLE AND GRAPH (BLANK)**

8. Adjusting and Cleaning

- a. Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying and other activities to their original condition in accordance with other sections of this specification. Maintain restored surfaces.

**END OF SECTION**

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**SECTION 26 05 29****HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Types of supports, anchors, sleeves, seals and fastenings specified in this Section include the following:
  - 1. Clevis hangers
  - 2. C-Clamps
  - 3. Toggle bolts
  - 4. One-hole raceway straps
  - 5. Two-hole raceway straps
  - 6. Wall and floor seals

**1.02 REFERENCE STANDARDS**

- A. Applicable only to the extent specified.
  - 1. Federal Aviation Administration (FAA)
    - a. FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment, latest edition
  - 2. National Fire Protection Association (NFPA)
    - a. 70 National Electrical Code (NEC), latest edition
  - 3. American Standard for Testing and Materials (ASTM)
    - a. A1011 SS GR 33 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

**1.03 ACTION SUBMITTALS**

- A. Parsons WRPM approval is required for all submittals. Submit the following:
  - 1. Product data for each type of product specified.

#### 1.04 QUALITY CONTROL

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70, (NEC) latest edition. Electrical components shall be listed and labeled by UL or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

### PART 2 - PRODUCTS

#### 2.01 GENERAL

- A. Materials procured and installed in this Section shall be in accordance with FAA-C-1217, and FAA-STD-019.

#### 2.02 COATINGS

- A. Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

#### 2.03 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, raceway straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps comply with NEC, latest edition and the following requirements:
  - 1. Conform to manufacturer's recommendation for selection of supports.
  - 2. Strength of each support shall be adequate to carry the design load plus 25 percent for future use, multiplied by a safety factor of at least of four. Where this determination results in a safety of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
- B. Fasteners: Types, materials, and construction features as follows:
  - 1. Expansion Anchors: 1/2 inch lead expansion anchors approximately 38 pounds per 100 units.
  - 2. Toggle Bolts: 3/16 inch by 4 inch spring head toggle bolts approximately 5 pound per 100 units.
- C. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- D. Channel Systems (U-Channel): Conform with A1011 SS GR 33. 16-gauge channels, stainless steel type 304 for outdoor locations, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.
- E. Raceway Sealing Bushings: Factory-fabricated assembly consisting of threaded body and insulating wedging plugs for non-armored electrical cables in raceways subject to exposure to water and/or oil penetration at raceway joints. Provide plugs with number and size of conductor gripping holes as required to suit installation. Construct body of malleable iron casting with hot-dipped galvanized finish.

- F. Raceway Sleeves and Seals: Provide raceway sleeves and seals of types, sizes and materials indicated with the following features:
  - 1. Provide factory-assembled watertight wall and floor seals of types and sizes suitable for sealing raceway, pipe, or tubing passing through concrete floors and walls. Construct with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps and cap screws.
- G. Continuous Slotted Channels: Dimensions as required for loads imposed.
- H. Clamps: Sized for application.

#### 2.04 FABRICATED SUPPORTING DEVICES

- A. General: Shop or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves for steel pipe to be fabricated from Schedule 40 galvanized steel pipe.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC latest edition requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC latest edition and the following requirements:
  - 1. Conform to manufacturer's recommendations for installation of supports.
  - 2. Space supports for raceways in accordance with the NEC latest edition.
  - 3. Support exposed and concealed raceway within 3 feet of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
  - 4. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the raceway supports with no weight load on raceway terminals.
- D. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- E. Cable Supports:

1. Install in strict compliance with manufacturer's instructions.
  2. Spacing not to exceed NFPA 70, latest edition, tabulation for spacing of conductor supports.
  3. Allow adequate slack in conductors to prevent any stress on terminations. Take into consideration conductor thermal contraction.
  4. Train cables for a neat and orderly installation.
- F. Sleeves: Install in concrete slabs and walls for raceways and cable installations. Tighten sleeve seal nuts until sealing grommets have expanded to form a watertight seal.
- G. Fastening: Unless otherwise indicated, fasten electrical items (including but not limited to raceways, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, lighting fixtures and control components) and their supporting hardware securely to the building structure in accordance with the following:
1. Toggle bolts on hollow masonry units.
  2. Concrete inserts or expansion bolts on concrete or solid masonry.
  3. Machine screws, welded threaded studs, or spring-tension clamps on steel.
  4. Sheet metal screws in partitions of light steel construction.
  5. Threaded studs, driven by a powder charge and provided with lock washers and nuts, may be used instead of expansion bolts and machine or wood screws.
  6. Do not weld raceway (with the exception of exothermic welds for grounding), pipe straps, or items other than threaded studs to steel structures.
  7. 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 shall not cut the main reinforcing bars. Fill holes that are not used.
  8. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration and shock-resistant fasteners for attachments to concrete slabs.
- H. Tests:
1. Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:
    - a. Expansion anchors.
    - b. Toggle bolts.
    - c. Powder-driven threaded studs.

**END OF SECTION**

**SECTION 26 05 33****RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes furnishing material, equipment, labor and incidentals necessary to install a complete and operational system of raceways, fittings, boxes, enclosures, and cabinets for each type of electrical system.
- B. Types of raceways in this Division include the following:
  - 1. PVC coated rigid steel.
  - 2. Polyvinyl chloride raceway (PVC).
  - 3. Rigid steel (metal) raceway, zinc coated (RGS or RSC).
  - 4. Electrical metallic tubing (EMT).
  - 5. Liquidtight flexible metal raceway (LFMC).
- C. Types of boxes, enclosures, and cabinets in this Division include the following:
  - 1. Outlet boxes.
  - 2. Pull and junction boxes.
  - 3. Cabinets and enclosures with hinged covers.

**1.02 REFERENCE STANDARDS**

- A. The current issues of the following documents in effect on the date of the Request-For-Offers from part of this Specification and are applicable to the extent specified herein:
  - 1. American National Standards Institute (ANSI)
    - a. C80.1 Rigid Steel Raceway, Zinc-Coated RGS
    - b. C80.3 Electrical Metallic Tubing, Zinc-Coated (EMT)
    - c. C80.6 Intermediate Metal Raceway (IMC) Zinc-Coated
    - d. 870 Wireways, Auxiliary Gutters and Associated Fittings
  - 2. Federal Aviation Administration (FAA)
    - a. FAA-STD-019 Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities, latest edition
    - b. FAA-C-1217 Electrical Work, Premises Wiring, latest edition
    - c. FAA-C-1391 Installation, Termination, Splicing, and Transient/Surge Protection of Underground Electrical Distribution System Power Cables, latest edition
  - 3. Federal Specifications (FS)
    - a. W-C-586 Raceway Outlet Boxes, Bodies, and Entrance Caps

4. National Electrical Subcontractors Association (NECA)
5. National Electrical Manufacturers Association (NEMA)
  - a. FB1 Fitting, Cast Metal Boxes, and Raceway Bodies, and Cable Assemblies
  - b. OS1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
  - c. 250 Enclosures for Electrical Equipment (1000 Volts and Below)
  - d. ICS-6 Industrial Control System Enclosure
  - e. RN1 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Raceway
6. National Fire Protection Association (NFPA)
  - a. 70 National Electrical Code (NEC), latest edition
7. Occupational Safety and Health Administration (OSHA)
  - a. 29CFR1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
8. Underwriters Laboratories (UL). Materials having UL listing shall bear the UL label.
  - a. 6 Rigid Metal Raceway
  - b. 50 Enclosures for Electrical Equipment
  - c. 360 Liquid-tight Flexible Metal Raceway
  - d. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
  - e. 514A Metallic Outlet Boxes
  - f. 514 B Fittings for Raceway and Outlet Boxes
  - g. 797 Electric Metallic Tubing
  - h. 870 Wireways, Auxiliary Gutter, and Associated Fittings
  - i. 1242 Intermediate Metal Raceways
  - j. 651 PVC Raceway
9. Steel Structures Painting Council (SSPC)
  - a. PS-10.01 Hot-applied coal tar enamel painting system.

#### 1.03 ACTION SUBMITTALS

- A. Parsons WRPM approval is required for all submittals. Submit the:
  1. Manufacturer's product data for all raceway and fittings, floor boxes, hinged cover enclosures, and cabinets. Include specifications, installation instructions and general recommendations.

#### 1.04 APPLICATIONS

- A. Provide boxes in the wiring and raceway system for pulling wires, making connections.

## 1.05 QUALITY CONTROL

- A. Comply with latest edition of the NFPA 70 "National Electrical Code" latest edition for components and installation.
  - 1. Size boxes in accordance with NEC Article 370.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
  - 1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.
  - 2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.
- C. Comply with NECA "Standard of Installation."
- D. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

## 1.06 SHOP DRAWINGS

- A. Submit dimensioned drawings of raceway and wireway systems showing layout of raceway at all congested areas such as above and below panelboards.

## PART 2 - PRODUCTS

### 2.01 GENERAL:

- A. Enclosures: Conform to NEMA standards.
- B. Procure materials under this specification in accordance with FAA-C-1217, and FAA-STD-019.
- C. Raceway size: Adequately size raceways to include the phase conductors, an equipment ground conductor (green) and a neutral conductor (gray or white) in accordance with percentage fill requirements by NFPA 70 (NEC) latest edition.
  - 1. Provide 1/2 inch raceway minimum unless otherwise indicated on Contract Drawings.

### 2.02 RACEWAY AND TUBING

- A. Rigid Steel Raceway: Heavy wall mild steel tube with metallic corrosion resistant coating on exterior and interior, hot dipped galvanized steel, free from defects; Manufactured in accordance with Federal Specification W-C-581, ANSI C80.1 and UL 6.
- B. PVC Coated Steel Raceway: Meeting the requirements of Rigid Steel Raceways; 40mil PVC exterior coating and urethane interior coating, in accordance with NEMA RN 1.
- C. Electrical Metallic Tubing: Welded steel tubing, formed of low carbon steel, electro-galvanized exterior, inside coated with a baked, elastic low-friction coating of enamel, in accordance with Fed. Spec. WW-C-563, ANSI C80.3 and UL 797.

- D. Liquidtight Flexible Metal Raceway (LFMC): Flexible steel raceway with PVC jacket: Liquidtight raceway shall have an extruded, polyvinyl jacket over the flexible metal in accordance with UL 360
  - 1. Flexible non-metallic raceway shall not be used.
- E. Rigid Non-Metallic Raceway (PVC): Schedule 80 high impact, polyvinyl chloride, in accordance with Federal Specification W-C-1094 and UL 651 listed.

## 2.03 RACEWAY FITTINGS, COUPLINGS AND CONNECTORS

- A. Material: Use fittings listed and approved for specific raceway or raceway system used.
- B. Bushings and connectors: Bushings and connectors shall be insulated type which maintain continuity of raceway ground system. Insulating material shall be molded or locked into metallic body of the fitting. Bushing made entirely of nonmetallic material will not be allowed.
- C. Fittings and Raceway Bodies: UL 514B and NEMA FB 1, compatible with raceway and of the threaded type.
  - 1. Rigid Steel Raceway: Threaded type material to match the raceway, in accordance ANSI/NEMA FB1.
  - 2. Rigid Non-Metallic Raceway: Solvent-welded, slip-on joints.
  - 3. Below Grade Installations: For installation below slab, on-grade, or underground, the raceway shall be factory coated with either 0.008 inch of epoxy, 0.020 inch of polyvinyl chloride or 0.063 inch of coal-tar enamel or shall be field wrapped with 0.01 inch thick pipe wrapping plastic tape applied with 50% overlap.
  - 4. Electrical Metallic Tubing: Fittings used with EMT shall be compression-type fittings designed for this type of raceway, unless otherwise indicated. Screw-type fittings are not acceptable. Connectors shall have insulated-throat, smooth bell shaped end or a bushing.
  - 5. Set Screw fittings are not allowed.
- D. Liquidtight Flexible Metal Conduit (LFMC) Fittings: Liquidtight Flexible metal conduit fittings must be made of galvanized steel. They must be insulated and one of the following types.
  - 1. Wedge and screw type having an angular wedge fitting between the convolutions of the raceway.
  - 2. Steel, multiple point type, for threading into the internal wall of the raceway convolutions.
- E. Inferior Metal: Inferior material such as “pot metal” is not permitted for any type of fitting.
- F. Lock Nuts: Use bonding type locknuts with sharp edges for digging into the metal wall of the enclosure.
- G. Frangible Couplings: Use break away frangible couplings with applied load not to exceed 75 lbs. Design frangible couplings and mounting flanges for use with 2-inch (51 mm) electrical metallic tubing (EMT) and suitable for mounting on a concrete pad. Apply anti-seizing compound on the threads of the frangible couplings prior to insertion into the rigid couplings and mounting flanges.

## 2.04 OUTLET BOXES

- A. Sheet Metal Boxes: NEMA OS 1 and UL 514A; Galvanized steel with 1/2 inch male fixture studs where required.



- B. Cast Metal Boxes: NEMA FB 1, type FD, cast alloy box with gasketed cover, threaded hubs. Use cast boxes for damp and outdoor locations.
- C. Fittings: UL 514B.

#### 2.05 PULL AND JUNCTION BOXES:

- A. Small Sheet Metal Boxes: NEMA OS 1 and UL 514A.
- B. Cast Metal Boxes:
  - 1. Threaded-hub type conforming to UL 514A and UL 514B.
  - 2. Galvanized steel conforming to UL 514A and UL 514BB
- C. Covers: Class 30B gray cast iron conforming to ASTM-8, machine finished with flat bearing surfaces.

#### 2.06 INTERIOR/EXTERIOR CABINETS AND ENCLOSURES

- A. Hinged Cover Enclosures: NEMA 250, steel enclosure with continuous hinge cover and flush latch. Finish inside and out with manufacturer's standard enamel.
- B. Cabinets and enclosures: NEMA 250, code gauge galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

Cabinets and enclosures shall be constructed with interior dimensions not less than those indicated on the Contract Drawings. Other requirements:

- 1. Provide 5/8 inch plywood backboard unless otherwise indicated.
  - 2. Key latch to match panelboards. Provide two keys with each cabinet unless otherwise notified.
  - 3. NEMA 1 rated for interior cabinets and enclosures.
  - 4. NEMA 3R rated for exterior cabinets and enclosures for power equipment.
  - 5. NEMA 4X (fiberglass) Exterior cabinets and enclosures for splice/communication/control.
  - 6. Use one (1) latch or securing device on each of the three non-hinged sides for exterior cabinet front covers . If the cabinet cover is not hinged it shall have a minimum of one (1) latch or securing device on each of the four sides.
- C. Safety: UL 50.
  - D. Locks: All locks in this project shall be keyed alike.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine raceways prior to installation. No crushed or deformed raceway shall be installed.
- C. Provide electrical boxes in locations shown on the plans and as required for splices taps, wire pulling equipment connections and code compliance.

### **3.02 WIRING METHODS**

- A. Outdoors: Use the following wiring methods:
  - 1. Underground Encased Concrete Ductbank: PVC Coated Rigid galvanized steel raceway and fittings.
  - 2. Exposed: Rigid steel raceway, unless otherwise indicated on Contract Drawings.
  - 3. Underground, Single or Grouped Run: Rigid steel/PVC raceway and fittings as indicated on Contract Drawings.
  - 4. Connection to Vibrating Equipment (including transformers) liquid-tight flexible metal raceway.
  - 5. Boxes and Enclosures: NEMA Type 3R and/or Type 4X, as specified in Part 2.
- B. Indoors: Use the following wiring methods:
  - 1. Connection to Vibrating Equipment: Flexible metal raceway, except in wet or damp locations, uses liquid-tight flexible metal raceway.
  - 2. Damp or Wet Locations: Rigid steel raceway.
  - 3. Exposed: Rigid steel raceway. Use rigid steel raceway in the electrical/mechanical rooms to a height of 8 feet above finished floor.
  - 4. Boxes and Enclosures: NEMA Type 1.
- C. Raceway Use:
  - 1. Install rigid steel raceway (RSC) for all distribution panel feeders, transformer feeders.
  - 2. Use rigid steel or PVC raceway and fittings for underground ductbanks as indicated on Contract Drawings.
  - 3. Use PVC coated rigid galvanized steel raceway for all raceway systems installed in contact with earth.
  - 4. Ends of raceway systems not terminated in boxes or cabinets shall be capped.
  - 5. Where raceways enter enclosures without hubs, use an appropriate connector with threads and locknuts to securely bond the raceway to the enclosure.
  - 6. Install the connector body (insulated-throat type) and locknut so that firm contact is made on each side of the enclosure.
  - 7. EMT may be used only in dry interior locations, and where not subject to physical damage.
  - 8. Do not use EMT on circuits above 600 volts or in sizes greater than 4 inches in diameter.
  - 9. Use EMT above grade in conjunction with frangible fittings as indicated on Contract Drawings.

### 3.03 INSTALLATION:

#### A. Provide products in accordance with:

1. FAA-C-1217
2. FAA-C-1391
3. FAA-STD-019

#### B. Raceway:

1. Minimum size for raceway power circuits shall be 1/2 inch, unless otherwise noted.
2. Raceway for telephone and signal systems shall be as follows:
  - a. 1/2-inch raceway may be used for lengths not exceeding 50 feet. 3/4-inch raceway may be used for lengths not exceeding 100 feet.
  - b. 1-inch raceway shall be used for lengths exceeding 100 feet.
3. Do not exceed more than four (4) 90-degree bends, or the equivalent between boxes. Provide pull and junction boxes required to meet this criteria.
4. Size raceways as required by the NEC for the number and sizes of wires to be pulled into the raceway.
5. Use raceway bodies to make sharp changes in directions around ground beams.
6. Use temporary closures/caps to prevent foreign matter and moisture from entering raceway.
7. Use raceway fittings suitable for use and location.
8. Raceway under/embedded in slabs: Install in middle third of the slab thickness where practical, and leave at least 1 inch concrete cover.
  - a. Secure raceway to reinforcing rods to prevent sagging or shifting during concrete placement.
  - b. Space raceway laterally to prevent voids in the concrete.
  - c. Run raceway larger than 1-inch trade size parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place raceway close to slab support.
9. For installation below slab, on-grade, or underground, use PVC-coated Rigid Steel Raceway. Protect fittings used underground by field wrapping with 0.01-inch-thick pipe wrapping plastic tape applied with 50% overlap.
10. Field Cut Raceway: Where raceway has to be cut in the field, cut square using a hand or power hacksaw or approved pipe cutter using cutting knives. Ream the cut ends of the field-cut raceway to remove burrs and sharp edges.
11. Field Threaded Raceway: Where threads have to be cut on raceway, the threads shall have the same effective length and shall have the same thread dimension and taper as specified for factory-cut threads on raceway.
12. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, or where raceways enter enclosures without threaded hubs, use two locknuts, one inside and one outside the box to securely bond the raceway to the enclosure.
  - a. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

13. Bushings: Install a bushing on the interior threaded end of each raceway to protect conductor insulation.
  14. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel. Where space conditions prohibit the use of standard elbows, use ferrous alloy fittings to, match the raceway construction. "Condulet" type fittings shall not be used on raceways containing 4 AWG or larger wire.
    - a. Bends in raceway that is 1 inch and larger shall have a minimum inside radii 12 times the nominal raceway diameter.
  15. Frangible Couplings: Locate the point of frangibility no higher than 3-inches above grade when installed.
- C. Raceways:
1. Complete raceway installation before starting conductor installation. Inside of raceways must be reamed, deburred, fished and swabbed before conductors are pulled.
- D. Support:
1. Support raceways, boxes, cabinets and enclosures in accordance with Section 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
- E. Floor and Wall Penetrations:
1. Seal penetrations through walls or floors separating the building interior from the exterior to prevent moisture and rodent entry and to deter air transfer.
  2. Seal penetrations of walls which separate individually temperature or humidity controlled areas, to prevent air circulation.
  3. Raceway sealing methods and sealants must be in accordance with the NEC.
  4. Conceal raceway unless otherwise indicated, within finished walls and ceilings.
- F. Exposed Raceways:
1. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
    - a. Run parallel or banked raceways together, and on common supports where practical.
    - b. Make bends in parallel or banked runs from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.
    - c. Install raceways at proper elevations. Provide adequate headroom.
- G. Joints:
1. Join raceways with fittings designed and approved for the purpose and make joints tight.
    - a. Use bonding locknuts and bushings at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
    - b. Use insulating bushings for all raceways to protect conductors.
- H. Pull Wire:

1. Install pull wires in empty raceways. Use 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-LB tensile strength. Leave not less than 24 inches of slack at each end of the pull wire.
- I. Stub-Up Connections:
1. Extend raceways through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor. Extend conductors to equipment with rigid steel raceway. Flexible raceway may be used 6 inches above the floor/pad in coordination with PM. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs flush with floor. Protect stub-ups from damage where raceways rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- J. Flexible Connections:
1. Flexible, liquid tight metal raceway:
    - a. Use maximum of 6 feet of flexible raceway for equipment subject to vibration, noise transmission, or movement; in wet or damp outdoor locations; and for all motors.
    - b. May be used for branch circuits in lengths longer than 6 feet in computer room locations which meet requirements of NEC Article 645.
    - c. Fittings and junction boxes shall be liquid tight under raised floors.
  2. A separate ground conductor shall be provided across all flexible raceway in addition to the equipment ground conductor run in the raceway with its related power conductors. This conductor shall be bonded to the connecting device at each end of the flexible raceway.
- K. Boxes:
1. Provide boxes in the wiring or raceway system for pulling wires, making connections, and mounting devices and fixtures. Each box must have the volume required by the NFPA 70 for the number and size of conductors in the box.
    - a. Pull/Junction Boxes: Plumb and level installation. Bring pull boxes tops flush with finished grade. Install type suitable for location (interior/exterior, dry/damp/wet).
    - b. Outlet Boxes: Each outlet box must have a machine screw which fits into a tapered hole into the box for the ground connection.
    - c. Wet locations: Cast metal boxes installed in wet locations and boxes installed flush with exterior surfaces must be gasketed.
    - d. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
    - e. Support boxes in accordance with Section 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS. At minimum provide support at each corner.
    - f. EMT entering an enclosure without threaded hubs: Provide a connector with threads and cast or machine lockout. The connector body and locknut shall be installed so that firm contact is made on each side of the enclosure.
    - g. Cap ends of raceway not terminated in boxes or cabinets to protect against entry of dirt and moisture.
    - h. Locate and install boxes to allow access. Where installation is inaccessible, coordinate locations and sizes of required access doors in accordance with other sections of the specification.
  2. Coordinate with other trades to determine proper placement and mounting heights of all devices, prior to rough-in.

L. Grounding:

1. Install grounding connections for raceway, boxes, and components in accordance with Section 26 05 26 GROUNDING AND BONDING OF ELECTRICAL SYSTEMS.

M. Protection

1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.
  - a. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - b. Repair damage to paint finishes with matching touch-up coating recommended by the manufacturer.

3.04 ADJUSTING AND CLEANING

- A. Upon completion of installation of system, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions and cover raceways and boxes to prevent entrance of foreign matter, paint, etc.
- B. Remove dirt and construction debris from outlet, junction, and pull boxes, and cabinets. Replace deformed raceways, boxes, cabinets and enclosures.
- C. Run a swab or mandrel to remove dirt or blockages from raceways.

**END OF SECTION**

**SECTION 26 05 33.10****UNDERGROUND CONDUITS FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes furnishing labor, materials, equipment, and incidentals necessary to install underground conduits and ducts, duct banks, pull cords, duct markers, capping of conduits, handholes, manholes, and other underground utility structures in accordance with dimensions, designs and details shown on the Contract Drawings. This Section also includes the testing of the installation as a completed system.

**1.02 REFERENCE STANDARDS**

- A. American National Standards Institute (ANSI)
1. C2 National Electrical Safety Code
  2. C80.1 Rigid Steel Conduit, Zinc-Coated
- B. Federal Aviation Administration (FAA)
1. FAA-C-1391 Installation, Termination, Splicing, and Transient/Surge Protection of Underground Electrical Distribution System Power Cables, latest edition
- C. American Society for Testing and Materials (ASTM)
1. C270 Specification for Mortar for Unit Masonry
  2. C387 Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
  3. C857 Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
  4. C858 Specification for Underground Precast Concrete Utility Structures
  5. C891 Specification for Installation of Underground Precast Concrete Utility Structures.
  6. C1037 Standard Practice for Inspection of Underground Precast Concrete Utility Structures
- D. National Fire Protection Association (NFPA)
1. 70 National Electrical Code (NEC), latest edition
- E. Occupational Safety and Health Administration (OSHA)
1. 29CFR Definitions and Requirements for a Nationally Recognized Testing 1910.7 Laboratory (NRTL).

### 1.03 DEFINITIONS

- A. Duct: Electrical conduit and other raceway, used underground, embedded in earth or concrete.
- B. Duct Bank: Two (2) or more conduits or other raceway installed underground in the same trench or concrete envelope.
- C. Handhole: An underground junction or pull box interconnected with a duct or duct bank.

### 1.04 ACTION SUBMITTALS

- A. Parsons WRPM approval is required for all submittals. Submit the following:
  - 1. Product data for metal accessories for handholes, conduit and duct, duct bank materials, trench marking tape and miscellaneous components.
  - 2. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C 858.
  - 3. Inspection report for factory inspections, according to ASTM C 1037.
  - 4. Coordination drawings showing duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to accurate scale.
  - 5. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their expertise, capabilities and experience.
  - 6. Field test reports indicating and interpreting test results relative to compliance with performance requirements of "Field Quality Control" Article in Part 3 of this Section.
  - 7. Record Documents: Show dimensioned locations of underground ducts and handholes.

### 1.05 QUALITY CONTROL

- A. Manufacturer Qualifications: Firm experienced in manufacturing underground precast concrete utility structures of types and sizes required and similar to those indicated for this Project. Firm must have a record of successful in-service performance.
- B. Comply with NFPA 70, NEC latest edition, and ANSI C2 for components and installation.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
  - 2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.
- D. Coordinate layout and installation of ducts and ductbank handholes with final arrangement of other utilities as determined in the field.
- E. Coordinate elevations of duct and duct bank entrances into handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and ensure duct runs drain to handholes, and as approved by the PM Designee.
- F. Install underground ductbanks and handholes in accordance with the requirements of the local power company and local telecommunications company, as appropriate.



## 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to site with ends capped.
- B. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. All equipment and materials covered by this referenced specification shall be subject to acceptance through the manufacturer's certification of compliance with the applicable specification when so requested by the PM Designee.
  - 1. Concrete: Concrete for precast handholes shall be the manufacturer's standard mix for obtaining minimum compression strength of 3000psi or as shown on Contract Drawings. Concrete shall be air entrained. Concrete shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.
  - 2. Mortar: Conform to ASTM C270, Type M, except for quantities less than 2.0 cu. ft. (60 L), where packaged complying with ASTM C387, Type M may be used.
  - 3. Handholes: Provide pre-cast handholes as follows:
    - a. Dimensions shall be as noted on Contract Drawings.
    - b. The number of conduit or terminators entering the handhole shall not be less than as detailed on the plans. Provide knockouts windows in unused sides of the handhole and sleeves for ground connection.
    - c. Interlocking, mating sections, complete with accessory items, hardware, and features as indicated.
    - d. Joint Sealant: Continuous extrusion of asphaltic butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand the maximum hydrostatic pressures at the installation location with the ground water level at grade.
    - e. Design structure according to ASTM C858.
    - f. Structural Design Loading: ASTM C857, Class A-16.
    - g. Fabricate according to ASTM C858.
    - h. Design loads shall consist of dead load, live load, impact load, loads due to water table and any other loads which may be imposed upon the structure. Live loads shall be for Aircraft or H2O loading as shown on Contract Drawings.
    - i. Prepare and submit detailed shop drawings for pre-cast handholes indicating reinforcement, dimensions and details of each miscellaneous item. The handhole design shall be checked by a Registered Professional Engineer in the state where project is located. All handhole drawings shall bear Registered Professional Engineer's Seal and signature.
      - 1) All shop drawings shall be checked by the fabricator before being submitted for approval to the WRPM.
      - 2) Be responsible for the correctness and completeness of the drawings and fit and field connections even if the drawings have been approved by the WRPM.
    - j. All reinforcing steel, including welded wire mesh, shall be of the size and in the location as shown on the plans. All reinforcing must be sufficiently secured to withstand any

displacement during the pouring operation. Reinforcing steel shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE

- k. Duct terminators:
    - 1) Terminators must be formed of high impact, high strength, prime virgin acrylonitrile butadiene styrene (ABS) plastic, containing the proper number, size, and arrangement of openings to receive ducts as shown on the plans, with 2-inch nominal separation between openings.
    - 2) Terminators shall be hollow, to allow placement of reinforcing steel inside. Terminators shall provide for reception of future ducts and factory plastic plugs of proper size. Plugs shall be furnished and installed in all empty duct openings. Installation in handholes shall be in accordance with manufacturer's instructions.
  - l. Use bolt-down type covers. with built-in, flush lifting eyes for ease of cover lifting. Bolted-on or U-bolt type devices shall not be acceptable as cover lifting eyes.
  - m. Frames and covers shall be constructed of the materials as specified and in accordance the details shown on the plans and shall be placed carefully to the lines or grades indicated on the plans or as directed by the PM Designee. Covers shall be stamped "Power," "Control" "Telco" or "Comm." as applicable.
  - n. Source Quality Control: Inspect structures according to ASTM C1037.
- 4. Trench marking Tape: All duct banks shall be marked with marking tape. Tape shall run continuous in the trench 6 inches below the surface or as indicated on the drawings. Marking tape shall be red, bright orange or yellow colored tape. Lettering shall read "Power," "Control," or "Comm." as applicable.
  - 5. Duct ball markers (ALSF Only): All duct banks/buried cables shall be marked with ball markers. Ball markers shall be placed two feet below finished grade, directly above the duct bank, a maximum of 200 feet apart along the trench end and at the beginning, middle and end of each curve of the duct banks as shown on contract drawings. Ball markers shall be 4" diameter, having self-leveling design and a passive-tuned antenna molded inside a plastic disc which is free-loading within a waterproof polyethylene shell. The ball marker shall have a range of four feet and color coded as follows:
    - a. Orange for "Communication".
    - b. Red for "Power" and "Power/Communication".
    - c. Blue for "Splices" and "Ends of Ductbanks".

## 2.02 CONDUIT AND DUCT

- A. Rigid Steel Conduit (RSC): ANSI C80.1, galvanized.
- B. Rigid Non-Metallic Conduit (PVC): Schedule 80 high impact, polyvinyl chloride, in accordance with Federal Specification W-C-1094 and Underwriters Laboratories Standards UL-651 and 651A.
- C. Accessories:
  - 1. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting.
  - 2. Grounding: Provide grounding in accordance with Section 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
  - 3. Duct Sealing Compound: Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 deg F, withstands temperature of 300 deg F without slump, and adheres to clean surfaces of metallic conduits, conduit

coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals.

### **PART 3 - EXECUTION**

#### **3.01 GENERAL**

- A. Installation shall adhere to the requirements indicated on the construction plans and details and as specified below:
  - 1. Underground Ducts For Electrical Utility Service: PVC or Rigid steel conduit, encased in concrete as indicated on Contract Drawings.
  - 2. Underground Ducts For Telecommunications Utility Service: PVC or Rigid steel conduit, encased in concrete or indicated on Contract Drawings.

#### **3.02 EXAMINATION**

- A. Examine site to receive ducts and handholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and handholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### **3.03 CONDUIT AND DUCT INSTALLATION**

- A. Install conduit and duct as indicated on drawings. Grading of pullboxes and associated interconnecting ducts shall be shown on the plans.
- B. Slope: All duct lines shall be laid so as to drain toward handholes, unless otherwise shown on the drawings. Pitch ducts minimum of 1 inches vertical per 100 feet to drain toward handholes and away from buildings and equipment. Slope ducts from a high point in runs between two handholes to drain in both directions.
- C. Curves and Bends: Manufactured bends shall have a minimum of 24 inches for a 2-inch duct and 48 inches for a 4-inch duct.
- D. Joints: Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- E. Duct Entrances to Handholes: Provide ground bushings where RGS ducts enter handholes.
- F. Underground Warning Tapes: Install above all underground conduit installations. Locate six (6) inches below finished grade.
- G. Size: Where no size is indicated on the plans, the ducts shall not be less than 4 inches inside diameter.
- H. Concrete-Encased Ducts: Support on plastic separators, coordinated with duct size and required duct spacing, and install according to the following:
  - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting.

- Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups. Minimum separator spacing shall be 5 feet.
2. **Concreting:** Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other termination's in 1 continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into the concrete on both sides of joint near the corners of the envelope.
  3. **Reinforcing:** Reinforce duct banks where they cross high traffic areas. Install reinforcing in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
  4. **Forms:** Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions, otherwise, use forms.
  5. **Minimum Clearances Between Ducts:** 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 12 inches between power and signal ducts.
  6. **Depth:** Except as otherwise indicated, install top of duct bank at least 36 inches below finished grade.
  7. **Obstructions:** In the event any obstructions are encountered, inform the PM Designee immediately.
  8. **Install trenches for duct banks in accordance with pertinent requirements of all sections of this Specification.**
  9. **Assemble duct joints with a solvent cement for conduit type and applied as directed by the manufacturer. Stagger any duct joints in the duct bank, both horizontally and vertically, a minimum of one foot to increase structural integrity of the duct bank installations. No two duct joints shall lie in the same transverse plane in a vertical or horizontal direction. These provisions shall also apply at all ducts installed for future extensions.**
  10. **Notify the PM Designee at least six hours before starting to place backfill in any duct to permit the inspection of ducts and spacers. Where mechanical compactors are used, care shall be taken so as to not injure and displace the ducts.**
- I. **Stub-Ups:** Use rigid steel conduit for stub-ups to equipment. Install insulated grounding bushings on the terminations.
  - J. **Sealing:** Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi hydrostatic pressure.
  - K. **Pulling Cord:** Polyolefin pull line with a minimum tensile strength of 200 pounds shall be provided in conduits installed for future use.
  - L. **Conduit Joints:** Joints in plastic conduit shall be installed in accordance with the manufacturer's recommendations for the particular type of conduit.
  - M. **Duct Cleaning:** Mandrel each duct. An iron-shod mandrel, not more than 1/4 inch smaller than the bore of the duct shall be pushed through each duct by means of jointed conduit rods. The mandrel shall have leather or rubber gasket slightly larger than the duct hole. The Subcontractor shall completely and thoroughly swab clean each duct prior to cable installation.
  - N. **Conduit Termination:** Conduit shall terminate in duct terminators where the duct lines enter handholes. Where conduit risers are exposed above grade or slab, convert to RGS including last elbow below grade.
  - O. **Changes in direction:** Changes in direction of runs exceeding a total of 10 degrees, either horizontal or vertical, shall be accomplished by field preparation and installation of long sweep bends having a

minimum radius of curvature of 25 feet, in order to avoid kinks in the conduit, except that manufactured bends may be used at the ends of the run. The long sweep bends may be made up of one or more curved or straight sections and/or combinations thereof.

- P. Ducts: Spare ducts at the entrance to handholes, shall be plugged with a removable tapered plug, designed by the duct manufacturer, or with hardwood plugs conforming accurately to the shape of the duct and having the larger end of the plug at least 1/4 inch greater in diameter than the duct.
  - 1. All ducts shall be securely fastened in place during construction and shall be plugged to prevent seepage of grout, water or dirt. Any duct section having a defective joint shall be repaired or replaced prior to backfill.

### 3.04 UNDERGROUND UTILITY STRUCTURE INSTALLATION

- A. Elevation: Install handholes with roof of handhole at finished floor or grade. Install handholes with depth as required based on ductbank elevations and sloping requirements.
- B. Access: Install cast-iron frame and cover. Install handhole cover as indicated on Contract Drawings.
- C. Cast-In-Place Underground Structure Installation: Conform to applicable requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.
- D. Finish interior surfaces with a smooth troweled finish.
- E. Precast Underground Structure Installation: Install as indicated on Contract Drawings and according to manufacturer's written instructions and ASTM C891.
  - 1. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.
  - 2. Support units on a level bed of crushed stone or gravel, graded from the 1-inch sieve to the No. 4 sieve and compacted to same density as adjacent undisturbed earth.
  - 3. Defects: Minor cosmetic defects in the concrete which do not affect the strength of the handhole, or expose the steel reinforcement, maybe accepted if the defects are properly patched and do not cover more than a total area of 4 square feet.
  - 4. Joints: The joints between different handholes shall provide a surface area of sufficient size and dimensions to provide adequate lateral strength and prevent moisture egress with the sealant provided by the manufacturer. All joints shall be on the horizontal plane with a maximum of two joints per box. The joint utilized between sections shall be as indicated in the Contract Drawings. The separation between different handhole sections at joints shall not vary more the 2 inches from the point of least separation to the greatest separation. Excess sealant shall be removed and surface projections shall be removed before backfill operations begin.

### 3.05 EARTHWORK

- A. Excavation, Backfill and Compacting: Conform to Section 31 20 00 EARTH MOVING but do not use heavy-duty hydraulic-operated compaction equipment.

### 3.06 RESTORATION

- A. All areas disturbed by the trenching, storing of dirt, cable laying and other work shall be restored to its original condition in accordance with Division 2. Maintain all disturbed surfaces and replacements until final acceptance.

### 3.07 FIELD PREPARATION

- A. Prepare a hole large enough to accommodate the outside dimensions of the Structure as shown on the drawings.
  - 1. Prior to setting, provide 6"-8" inches of 3/4 inch crushed stone as a base to receive the handhole.
  - 2. The base material shall be compacted and graded level and at proper elevation to receive the handhole in proper relation to the conduit grade and ground cover requirements as shown on the plans.
  - 3. After primary structure has been properly installed, excavation shall be backfilled.

### 3.08 MISCELLANEOUS ITEM INSTALLATION

- A. Welding will not be permitted unless shown otherwise on the approved shop drawings. Equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the PM Designee and approval of the method of correction shall be obtained. Approved corrections shall be made at the installer's expense.
- B. Anchor Bolts: Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately. All miscellaneous items shall be galvanized.
- C. Adjustment: After assembly, the various members shall be aligned and adjusted accurately before being fastened.
- D. Galvanizing touchup: Apply liquid-cold galvanizing compound conforming to U.S. Navy Galvanizing Repair Specification MIL-P-21035 to galvanized surfaces damaged during installation. Surfaces shall be cleaned and compound applied in accordance with manufacturer's recommendation.
- E. Grounding: Install handhole grounding in accordance with Section 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

### 3.09 FIELD QUALITY CONTROL

- A. Testing: Demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.
  - 1. Grounding: Test handhole grounding in accordance with Section 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
  - 2. Duct Integrity: Rod ducts with a mandrel 1/4 inch smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest.
- B. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

### 3.10 CLEANING

- A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2 inch greater than internal diameter of duct.
- B. Clean internal surfaces of handholes including sump. Remove foreign material.

**END OF SECTION**

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**SECTION 26 05 48****VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Elastomeric isolation pads.
2. Restraints - rigid type.
3. Restraints - cable type.
4. Restraint accessories.
5. Post-Installed concrete anchors.
6. Concrete inserts.

**B. Related Requirements:**

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 05 29 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

**1.02 ACTION SUBMITTALS****A. Product Data: For each type of product.**

1. Include rated load capacity for each seismic-restraint device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
4. Annotate to indicate application of each product submitted and compliance with requirements.

**B. Shop Drawings:**

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

**C. Delegated Design Submittal for Each Seismic-Restraint Device: Signed and sealed by qualified structural professional engineer.**

1. For each seismic-restraint device, including restraint - rigid and cable type, that is required by this Section or is indicated on Drawings, submit the following:

- a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
  - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
  - c. Seismic Design Calculations: Submit input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
- D. Delegated Design Submittal for Each Wind-Load Protection Device: Signed and sealed by qualified structural professional engineer.
  - 1. For each wind-load protection device, including restraint - rigid and cable type, that is required by this Section or is indicated on Drawings, submit the following:
    - a. Wind-Load Restraint: Select wind-load restraints complying with performance requirements, design criteria, and analysis data.
    - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind loads. Include certification that device is approved by an NRTL for reinforcement use.
    - c. Wind-Load Design Calculations: Submit static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
  - 2. Seismic-Restraint Detail Drawings: Signed and sealed by qualified structural professional engineer.
    - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    - c. Coordinate seismic-restraint details with wind-load details required for equipment mounted outdoors.
  - 3. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

#### 1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage qualified structural professional engineer to design seismic control system in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical.

- B. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.
- C. Consequential Damage: Provide additional seismic restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.
- D. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- E. Component Supports:
  - 1. Load ratings, features, and applications of reinforcement components must be based on testing standards of a nationally recognized testing agency.

## 2.02 RESTRAINTS - RIGID TYPE

- A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.03 RESTRAINTS - CABLE TYPE

- A. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.
- B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

## 2.04 RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## 2.05 POST-INSTALLED CONCRETE ANCHORS

### A. Mechanical Anchor Bolts:

- 1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

### B. Adhesive Anchor Bolts:

- 1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

### C. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.

- 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
- 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

### D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

- 1. Undercut expansion anchors are permitted.

## 2.06 CONCRETE INSERTS

### A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

### B. Comply with MSS SP-58.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static and seismic loads within specified loading limits.

### 3.03 INSTALLATION OF SEISMIC-RESTRAINT DEVICES

- A. Provide seismic restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
  - 1. Install equipment and devices to withstand the effects of earthquake motions.
- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- C. Installation of seismic restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.
- D. Equipment Restraints:
  - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.
- E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:
  - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
  - 3. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 4. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in 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.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.05 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  4. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
- C. Nonconforming Work:
1. Seismic controls will be considered defective if they do not pass tests and inspections.
  2. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

**END OF SECTION**

**SECTION 26 05 53****IDENTIFICATION OF ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes identification of electrical materials, equipment, and associated installation. It includes requirements for electrical component identification, including but not limited to the following:
  - 1. Buried electrical line warnings
  - 2. Identification labeling for raceways, cables, and conductors
  - 3. Equipment labels and signs
  - 4. Panel Schedules

**1.02 REFERENCE STANDARDS**

- A. Applicable only to the extent specified.
  - 1. American Standards Institute (ANSI)
    - a. A13.1 Scheme for the Identification of Piping Systems
  - 2. Federal Aviation Administration (FAA)
    - a. FAA-C-1217 Electrical Work, Premises Wiring, latest edition
  - 3. National Fire Protection Association (NFPA), latest edition
    - a. NFPA 70 National Electrical Code (NEC), latest edition

**1.03 ACTION SUBMITTALS**

- A. Parsons WRPM approval is required for all submittals. Submit the following:
  - 1. Product Data: Product Data for each type of product specified.
  - 2. Schedule: Schedule of identification nomenclature, abbreviations and equipment designations to be used for identification signs.
  - 3. Samples: Samples for each color, lettering style, and other graphic representation required for identification materials; samples of labels and signs.
  - 4. Text: Size and lettering text on each nameplate.

#### 1.04 QUALITY CONTROL

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 latest edition
  - 1. ANSI Compliance: Comply with requirements of ANSI standard A13.1, "Scheme for Identification of Piping Systems", with regard to type and size of lettering for raceway and cable labels.
  - 2. National Fire Protection Association (NFPA): Comply with NFPA 70, latest edition, requirements for Identification and for provision of warning and caution signs for wiring and equipment.

#### 1.05 SEQUENCING AND SCHEDULING

- A. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

### PART 2 - PRODUCTS

#### 2.01 GENERAL

- A. Materials shall be in accordance with FAA-C-1217.
- B. Except as otherwise noted provide manufacturer's standard products of categories and types required for each application.
- C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Provide numbers, lettering and wording as approved in submittals as required by code or as recommended by the manufacturer.

#### 2.02 RACEWAY AND CABLE LABELS

- A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection optional, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. ANSI Compliance: Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.
  - 1. Color: White legend on a black field.
- C. Legend: Indicates voltage and source/service (and termination point for control cables). Adhesive Labels: Preprinted, flexible, self-adhesive vinyl. Legend is laminated with a clear, weather- and chemical-resistant coating.
- D. Engraved Plastic-Laminated Nameplates: Provide nameplates for all new equipment to match existing nameplates at site.



- E. Pre-tensioned, Wrap-around Plastic Sleeves: Flexible, preprinted, color-coded, acrylic bands sized to suit the diameter of the line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position. Tape Labels: Embossed adhesive tape with 1/4 inch (minimum) white letters on a black background.
- F. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- G. Underground Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
  - 1. Size: Not less than 6 inches wide by 4 mils thick.
  - 2. Compounded for permanent direct-burial service.
  - 3. Embedded continuous metallic strip or core.
  - 4. Printed Legend: Indicates type of underground line.
- H. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters for Designation purposes.
- I. Aluminum, Wraparound Marker Bands: Wrap-around bands cut from 0.014-inch-thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
  - 1. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.
- J. Copper, Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: Tags shall be circular in shape, two inches minimum diameter, by 0.02 inch thick for copper or by 0.05 inch thick for brass or aluminum.

## 2.03 ENGRAVED NAMEPLATES AND SIGNS

- A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provides single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Engraving stock: Melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 sq. in. or 8 inches in length; 1/8 inch thick for larger sizes. Minimum width of engraving stock shall be 2 times letter height.
- C. Engraved legend: Engraved three layers laminated plastic white letters on black background.
- D. Letter Height: Lettering for equipment identification shall be 3/8 inch high. Voltage rating and source lettering shall be 1/4 inch high.
- E. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched for mechanical fasteners, with colors, legend, and size as indicated or as otherwise required for the application. Use 1/4-inch grommets in corners for mounting.
- F. Wire and Cable Markers: Cloth markers, split sleeve or tube type.
- G. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396-inch, galvanized steel backing, with colors, legend, and size appropriate to the application. Use 1/4-inch grommets in corners for mounting. Signs shall be punched for mechanical fasteners.

- H. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.
- I. Tape Labels: Embossed adhesive tape with 1/4 inch (minimum) white letters on a black background.

#### 2.04 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties with the following features:
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength: 50 lb minimum.
  - 3. Temperature Range: Minus 40 to 185 deg F.
- B. Paint: Alkyd-urethane enamel over primer as recommended by enamel manufacturer.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION:

- A. Existing Nameplates: Install nameplates for all new equipment to match existing nameplates on site.
- B. Consistency: Use consistent designations throughout the Project.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
  - 1. Self-Adhesive Identification Products: Degrease and clean surfaces of dust, loose material, and oily films before applying.
- D. Raceway/Cable Identification of Special Systems: Identify raceways and exposed cables of special systems with color banding and black lettering appropriately sized for raceway. Band exposed and accessible raceways of the systems listed below for identification.
  - 1. Bands: Pre-tensioned, snap-around, colored plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling raceway place adjacent bands of 2-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25 feet in congested areas.
- E. Circuit Identification Labels on Boxes: Label externally as follows:
  - 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label, as well as “magic marker” on cover.
  - 2. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
- F. Underground Utility Line Warning Tape: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker with metallic tracer located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches, use a single line marker.

1. Install line marker for underground wiring, both direct buried and in raceway.
- G. Color Code Conductors: The following field-applied color-coding methods may be used in lieu of factory-coded wire listed in part 2 of Section 26 05 19 LOW VOLTAGE WIRES AND CABLES for sizes larger than No. 4 AWG. Demonstrate non-availability of factory colored wire before using this application.
1. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings. Where conductors are color coded by this method, they shall be color coded in accessible raceways, panelboards, outlets, and switches, as well as at all terminations. Conductors in accessible raceways shall be color coded so that by removing or opening any cover, the coding will be visible.
  2. Green insulated conductors shall not be re-identified for purposes other than grounding.
  3. White or neutral gray conductors shall not be re-identified for purposes other than grounded neutrals.
- H. Power Cable Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in pull boxes, junction boxes, handholes, switchgear rooms, switchboard rooms, engine generator rooms, UPS rooms, and all electrical closets.
1. Legend: 1/4-inch letter and number, stamping or embossing, with legend corresponding to indicate circuit designations.
  2. Fasten tags with cable ties; fasten bands using integral ears.
- I. Conductor Identification for Other Systems:
- J. Install cable tags in each handhole with not less than two tags per cable, one near each duct entrance hole.
1. Attach tags to cable immediately after installation.
  2. Cable terminations shall be tagged as to function.
  3. Attach securely to cable using 1/8-inch nylon cord.
- K. Signage: Install warning, caution, and instruction signs as follows:
1. Install signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing in outdoor locations.
- L. Identification Labels: Install identification labels as follows:
1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. The first line shall show the equipment ID, the second line shall show the voltage and source.
  2. Apply labels for each unit of the following categories of equipment:
    - a. Panelboards, electrical cabinets, and enclosures
    - b. Access doors and panels for concealed electrical items
    - c. Transformers
    - d. Disconnect switches

- e. Enclosed circuit breakers
  - 3. Apply identification labels of engraved plastic laminate for disconnect switches, enclosed breakers, and similar items for power distribution and control components above, except panelboards where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.
- M. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- N. Tag cables in each handhole with not less than two tags per cable, one near each duct entrance hole.
  - 1. Attach tags to cable immediately after installation.
  - 2. Cable terminations shall be tagged as to function.
  - 3. Attach securely to cable using 1/8-inch nylon cord.
- O. Update all panelboards, new or existing, that have been modified by adding, removing, or relocating circuits. See panelboard schedule attached at the end of this section.

**END OF SECTION**

**SECTION 26 08 00.13****TESTING AND INSPECTING ELECTRICAL EQUIPMENT****PART 1 - GENERAL****1.01 DESCRIPTION**

- A. Requirements of Conditions of the Contract, Division 1, Contract Drawings and other Specification Sections form a part of this Section.

1. Work Included in This Section.
  - a. Testing of all electrical equipment.
2. Related Work Included in Other Divisions and Sections.
  - a. Basic Electrical Materials and Methods, Section 26 05 00.

**1.02 REFERENCES**

- A. The inspections and tests shall be in accordance with the following applicable codes and standards except as provided otherwise herein.
1. FAA Order: JO 6950.22A Maintenance of Electrical Power Cables
  2. FAA Order: JO 6000.204 Maintenance of National Airspace System (NAS) Telecommunications Services
  3. FAA Form 6030-17 Technical Reference Data Record
  4. National Electrical Code - NEC (NFPA 70) latest edition
  5. National Electrical Manufacturer's Association - NEMA
  6. American Society for Testing and Materials - ASTM
  7. Institute of Electrical and Electronic Engineers - IEEE
  8. National Electrical Testing Association - NETA
  9. American National Standards Institute - ANSI
  10. State and Local Codes and Ordinances
  11. Insulated Cable Engineers Association - ICEA
  12. Illuminating Engineering Society - IES
  13. OSHA Part 1910; Subpart S, 1910.308
  14. National Fire Protection Association - NFPA

**1.03 SUBMITTALS**

- A. Parsons WRPM approval is required for all submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. Prior to the Start of Work
  - a. Qualifications of Testing Service Company. The Owner reserves the right to disqualify any Test Service or testing personnel based upon qualification submitted.

- b. Contractors Test and Report Forms.
2. Upon completion of testing provide formal Test Report to include the following:
- a. Summary of project.
  - b. Description of equipment tested.
  - c. Description of test.
  - d. Test results.
    - 1) The following is a list of reports and forms that the Subcontractor or the Testing Service shall use in reporting the results:
      - a) Instrument Calibration Test and Data Sheet (2 sheets).
      - b) Low Voltage Circuit Breaker Test Report.
      - c) Insulation Resistance Test Report.
    - 2) Subcontractor may use its standard forms in place of the forms provided if they provide essentially the same information.
      - a) Submit forms for approval.
    - 3) Where test forms are not provided Subcontractor may provide its own forms.
      - a) Submit forms for approval.
  - e. Conclusions and recommendations.
  - f. Appendix, including appropriate completed test forms.
  - g. List of test equipment used and calibration date.

#### 1.04 QUALIFICATIONS

- A. The Testing Service shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907.
- B. Testing Services shall submit proof of the above qualifications to the Engineer.
- C. Electrical service companies such as Westinghouse or General Electric are assumed qualified, but must submit a statement of qualification of testing personnel and work histories shall specifically include FAA NAVAIDs equipment start-up and testing.

#### 1.05 SYSTEM DESCRIPTION

- A. The Contractor shall engage the services of a recognized Testing Service for the purpose of performing inspections and tests for equipment safety and operability, and functionally verify the control system operates in accordance with the contract documents.
- B. The Testing Service shall provide all material, equipment, labor and technical supervision to perform such tests and inspections.
- C. The intent of these tests is to assure that all electrical equipment is operational within industry and manufacturer's tolerances and to functionally test all electromechanical systems.

- D. Upon completion of the tests and inspections noted in these Specifications, a label shall be attached to all devices tested. These labels will indicate date tested, initial of the technician who conducted the test and the service company responsible.
- E. The tests and inspections shall determine suitability for continuous reliable operation.
- F. The Subcontractor may submit another electrical equipment test procedure in lieu of this Section to the Contractor for approval.
- G. The Subcontractor and the Electrical Testing Service shall resolve any deficiencies and retest in a timely manner to facilitate the project start-up and commercial operation.
- H. The inspections and tests shall utilize the following references.
  - 1. Project design Specifications.
  - 2. Project design Drawings.
  - 3. Manufacturer's instruction manuals applicable to each particular apparatus.
  - 4. Contractor generated drawings and documents.
  - 5. Contract Drawings submitted by manufacturers and vendors.
- I. All instruments used to evaluate electrical performance shall meet Specifications for Test Instruments (refer to Part 2 of this Specification).
- J. Electrical performance tests shall include the following:
  - 1. Control Panels.
  - 2. Low voltage circuit breakers.
  - 3. 600 volt feeder cables.
  - 4. System functions tests.
- K. The Subcontractor shall perform routine insulation resistance, continuity and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the Testing Service specified herein.
- L. The Subcontractor shall notify the Contractor when equipment becomes available for electrical tests. Work shall be coordinated to expedite project scheduling.
- M. The Subcontractor shall supply a set of electrical plans, specifications and any pertinent change orders to the Testing Service prior to commencement of testing.
- N. The Subcontractor shall notify the Contractor prior to commencement of any testing.
- O. The Testing Service shall be responsible for implementing the final settings and adjustments on protective devices and electrical equipment in accordance with approved values.
- P. Set points shall be noted on all calibration stickers.
- Q. Any system material or workmanship, which is found defective on the basis of electrical tests shall be replaced and retested at no additional cost to the Contractor.
- R. The Testing Service shall maintain a written record of all tests and upon completion of the project, assemble and certify a final test report.

## **PART 2 - PRODUCTS**

### **2.01 TEST INSTRUMENT TRACEABILITY**

- A. The Testing Service shall have a calibration program, which maintains applicable test instrumentation within rated accuracy.
- B. The accuracy shall be traceable to the National Institute for Standards and Technology in an unbroken chain.
- C. Instruments shall be calibrated in accordance with the following frequency schedule:
  - 1. Field instruments - 6 months maximum.
  - 2. Laboratory instruments - 12 months.
  - 3. Leased specialty equipment - 12 months. (Where accuracy is guaranteed in writing by the lessor.)
- D. Dated calibration labels shall be visible on all test equipment.
- E. Records must be kept up to date which show date and results of all instruments calibrated or tested.
- F. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.

## **PART 3 - EXECUTION**

### **3.01 SAFETY AND PRECAUTIONS**

- A. Safety practices shall include, but are not limited to, the following requirements:
  - 1. Occupational Safety and Health Act - OSHA.
  - 2. Accident Prevention Manual for Industrial Operations, Seventh Edition, National Safety Council, Chapter 4.
  - 3. Applicable State and local safety operating procedures.
  - 4. NETA Safety/Accident Prevention Program.
  - 5. National Fire Protection Association - NFPA 70 (NEC).
  - 6. National Fire Protection Association - National Electrical Safety Code.
- B. All tests shall be performed with apparatus de-energized except where otherwise specifically required herein.
- C. The Testing Service's lead test engineer for the project shall be a designated safety representative and shall be present on the project and supervise testing operations and safety requirements.
- D. Power circuits shall have conductors shorted to ground by a hotline grounding device approved for the purpose.
- E. In all cases, work shall proceed only when the safety representative has determined that it is safe to do so.



- F. The Testing Service shall have available sufficient protective barriers and warning signs to conduct specified tests safely, and shall post safety personnel as necessary while dangerous tests are being performed.
- G. The Contractor's safety procedures shall be reviewed and understood by the Subcontractors and Testing Service personnel.

### 3.02 SPECIAL REQUIREMENTS

- A. Testing of the equipment associated with the interconnection to the local utility is required to be tested in strict accordance with the methods and procedures of the "Power Producers Interconnection Handbook."
  - 1. Where the methods or procedures required under this Section are in conflict with the "Power Producers Interconnection Handbook" the requirements of the "Power Producers Interconnection Handbook" shall govern.
  - 2. The Testing Service is responsible for:
    - a. Obtaining the latest edition of the "Power Producers Interconnection Handbook."
    - b. Coordinating with the local utility in the performance of the required tests.

### 3.03 TEST PROCEDURES

- A. Circuit Breakers - Low Voltage
  - 1. Visual and Mechanical Inspection
    - a. Inspect for physical damage and nameplate compliance with single line diagram.
    - b. Mechanical operational tests shall be made in accordance with manufacturer's instruction manual.
    - c. Cell fit and element alignment shall be checked.
    - d. Check tightness of connections.
  - 2. Electrical Tests
    - a. A contact resistance test shall be performed.
    - b. An insulation resistance test shall be performed at 1,000 volts DC for one (1) minute from pole to pole and from each pole to ground and across open contacts of each phase.
    - c. Minimum pickup current shall be determined by primary current injection.
    - d. Long time delay shall be determined by primary injection at three hundred percent (300%) pickup current.
    - e. Short time pickup and time delay shall be determined by primary injection of current.
    - f. Instantaneous pickup current shall be determined by primary injection.
    - g. Trip unit reset characteristics shall be verified.
    - h. Adjustments shall be made for final settings in accordance with prescribed settings.
    - i. Auxiliary protective devices, such as ground fault or under-voltage shunt trip devices.
  - 3. Test Values
    - a. Contact resistance shall be determined in micro-ohms. values exceeding two hundred (200) micro-ohms or any values which deviate from adjacent poles or similar breakers by more than fifty percent (50%) should be investigated.

- b. Insulation resistance shall not be less than fifty (50) mega-ohms.
- c. Minimum pickup current, trip times and instantaneous pickup values shall be adjusted to approved settings. Test values should fall within manufacturer's published time-current characteristic tolerance band.

**B. Cables - Low Voltage (600 Volt Feeders)**

**1. Visual and Mechanical Inspections**

- a. Inspect exposed section for physical damage.
- b. Verify cable is supplied and connected in accordance with single line diagram.
- c. Inspect for cable support and termination.
- d. Visible cable bends shall be checked against ICEA or manufacturer's minimum allowable bending radius.

**2. Electrical Tests**

- a. Dielectric absorption ("megger") test.
  - 1) Tests shall be phase-to-phase and phase-to-ground.
  - 2) Test for 5 minutes at voltage given in Table 2.

**3. Test Values**

- a. Dielectric absorption test results.
  - 1) Minimum acceptable values of insulation resistance shall be as recommended by the cable manufacturer.
  - 2) Test should show no evidence of cable damage.

**END OF SECTION**

**SECTION 26 24 16****PANELBOARDS****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes furnishing materials, equipment, labor, and incidentals necessary to install lighting, power and distribution panelboards and associated auxiliary equipment rated 600V and less.

**1.02 REFERENCE STANDARDS**

- A. Applicable only to the extent specified.
1. Federal Aviation Administration (FAA)
    - a. FAA-C-1217 Electrical Work, Premises Wiring, latest edition
    - b. FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment, latest edition
  2. Federal Specification (FS)
    - a. W-P-115 Panel, Power Distribution
    - b. W-C-375 Circuit Breaker, Molded Case Branch Circuit and Service
  3. Institute of Electrical and Electronic Engineers (IEEE)
    - a. C62.41 Recommended Practice on Surge Voltage in Low-Voltage AC Power Circuits
  4. National Electrical Manufacturers Association (NEMA)
    - a. 250 Enclosures for Electrical Equipment (1000 Volts or Less)
    - b. PB1 Panel Boards
    - c. PB-1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards
    - d. PB-1.2 Application Guide for Ground-Fault Protective Devices and Equipment
    - e. AB1 Molded Case Circuit Breakers and Molded Case Switches
  5. International Electrical Testing Association (NETA)
    - a. ATS Acceptance Testing Specification for Electric Power Distribution Equipment and Systems
  6. National Fire Protection Association (NFPA)

- a. NFPA 70 National Electrical Code (NEC), latest edition
- 7. Occupational Safety and Health Administration (OSHA)
  - a. 29CFR1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
- 8. Underwriters Laboratories (UL)
  - a. 50 Electrical Cabinets and Boxes
  - b. 67 Panelboards
  - c. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
  - d. 489 Molded Case Circuit Breakers and Circuit Breaker Enclosures

#### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, circuit breaker, accessory item and component specified, include outline and support point dimensions, voltage, circuit breaker data arrangement and size.
- B. Shop Drawings: For panelboards, include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, voltage, and current rating. Include the following:
  - 1. Enclosure type with details for types other than NEMA 250, Type 1
  - 2. Bus configuration and current ratings
  - 3. Short-circuit current rating of panelboard to be not less than the available fault current
  - 4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include certified infrared scanning reports.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Maintenance Data: For panelboard components included in the maintenance manuals specified in Section 26 05 00.10 BASIC ELECTRICAL MATERIALS AND METHODS. Include manufacturer's written instructions for testing circuit breakers.

#### 1.04 QUALITY CONTROL

- A. Testing Agency Qualifications: Independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1910.7, or shall be a full member company of NRTL.
  - 1. Testing Agency's Field Supervision: Person currently certified by the International Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3 of this section.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled:" As defined in the National Electrical Code, Article 100.

- 2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.
- C. NFPA Compliance: Comply with NFPA 70, "National Electrical Code," latest edition.
- D. NEMA Compliance: Comply with NEMA PB 1, "Panelboards."
- E. Single Source Responsibility: Panelboards and circuit breakers located in the panelboards shall be the product of a single manufacturer.

#### 1.05 EXTRA MATERIALS

- A. Keys: Furnish two (2) keys to FAA for each panelboard installed.

### PART 2 - PRODUCTS

#### 2.01 GENERAL

- A. Materials procured in this Section shall be in accordance with FAA-C-1217, and FAA-STD-019.

#### 2.02 PANELBOARD FABRICATION

- A. Panelboard Type: Panelboards shall be of box dead-front type with circuit breaker equipped and shall conform to Federal Specification W-P-115, Type I, Class 1 and shall also be listed by UL except for installations which require special panelboards to incorporate items not available as UL listed.
- B. Enclosures: UL 50, general purpose, galvanized sheet steel, surface-mounted cabinets with baked-on gray enamel over a rust inhibitor as indicated on the drawings. Panelboards shall be listed and labeled by Underwriters Laboratories, Inc. in accordance with UL Standard 67, and shall conform to the latest requirements of the National Electrical Code, latest edition, and of NEMA Standard PB 1, Type 1, Class 1, unless otherwise indicated to meet environmental conditions at installed locations.
- C. Directory Frame: Metal, mounted inside each panelboard door.
- D. Main Bus: Hard drawn copper of 98 percent conductivity meet UL 67 temperature rise limits, and have a current density of 1000 amperes per square inch. Bus bars shall be sequenced-phased, and rigidly supported by high impact resistant, insulated bus supporting assemblies to prevent vibration or short circuits. Solderless terminations shall be suitable for copper UL listed wire or cable and shall be tested and listed in conjunction with appropriate UL standards.
  - 1. Bus capacity as indicated on Contract Drawings, or equal to or greater than the panelboard overcurrent protection device.
  - 2. Bus bars connections to bolt on branch circuit breakers shall be of the sequence phase type.
  - 3. Where provisions for "future" or "space" are noted on the drawings the panelboard shall be equipped with bus connections for the future installation of circuit breakers.
  - 4. Sequence style busing to accept bolt on molded case circuit breakers.
- E. Neutral Bus:
  - 1. Fully rated neutral bar capable of being located in either corner of the enclosure at the line ends to facilitate conductor termination and shall be insulated from panelboard.

2. Copper or plated copper neutral bus bar insulated from panelboard.
  3. Isolate neutral bus from all other busses except where the panelboard is used as the service disconnecting means.
- F. Equipment Ground Bus: Ground bus shall be copper, and adequate for feeder and branch-circuit equipment ground conductors with 25% additional space for future connections. Size lugs to accommodate grounding conductors shown on Contract Drawings.
1. Securely bond ground bus to the cabinet and separate from the neutral bus.
  2. The number of lug terminations shall be at least equal to the number of poles in the panelboard.
  3. The ground bus bar shall be structurally integral to the panelboard, or attached to the panelboard with a bolt, nut, and lock washer.
    - a. Bond conductor shall have same current carrying capacity as the largest equipment grounding conductor terminated to the ground bus bar.
- G. Short circuit rating: Panelboards shall be fully rated for short circuit. See Contract Drawings for short circuit rating.
- H. Future Devices: Equip phase busses with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.
- I. Panelboard Features: Include the following special features for panelboards.
1. Hinged Front Door in Door Construction: Entire front trim hinged to box with standard door within hinged trim cover (one-piece front with two doors). The smaller door, when open, provides access to device handles and rating labels and shall be lockable. The larger door, when open, provides access to conductors and wiring terminals. Door hinges shall be continuous piano hinges that are welded to the door(s) and bolt on front. All door hinges shall be concealed.
  2. Channel/Wiring Space: Shall be four inches wide for power feeders up to and including 100 amperes, six inches wide for power feeders over 100 amperes and up to and including 225 amperes, and eight inches wide for power feeders over 225 amperes and up to 600 amperes.
  3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and floor.
  4. Subfeed: Overcurrent protective device or lug provision as shown on Contract Drawings.
  5. Doors shall have flush type cylinder locks and catches. All locks in a project shall be keyed alike, and 2 keys shall be furnished with each lock.
- J. Wire Gutter Size: The minimum size of the side wiring gutters shall be 4 inches for power feeders up to and including 100 Amperes, 6 inches for power feeders over 100 Amperes and up to 225 Amperes and 8 inches for panelboards over 225 Amperes up to 600 Amperes.
- 2.03 OVER-CURRENT PROTECTIVE DEVICES
- A. Molded-Case Circuit Breaker: NEMA AB 1, UL 489, FS W-C-375, and the following requirements:
1. Bolt-on type. Stab-in and plug-in types are not acceptable.
  2. Quick make, quick break connections with mechanical trip, free switching mechanism.
  3. Inverse time, thermal trip for overloads. Automatic release secured by bi-metallic thermal element releasing the mechanism latch. Thermal trip calibrated for 40 degree C ambient temperature.

4. Instantaneous magnetic trip armature for short circuits.
  5. Multiple circuit breakers shall have an internal, common trip mechanism to open all poles simultaneously.
  6. Automatic trip indication as a color change in the trip indicator window and by a handle position between the manual "OFF" and "ON" positions.
  7. Full-sized single-pole breaker modules. Half sized breakers not allowed.
  8. Two and three pole breakers shall sized in multiples of a single-pole breaker;
  9. UL marked as suitable for use with 75 deg C wire.
  10. Series rated breakers not permitted.
- B. Characteristics: Provide frame size, trip rating, number of poles, auxiliary devices, voltage rating and interrupting capacity rating to meet available fault current as indicated on Contract Drawings.
1. Minimum interrupting rating: 10,000 AIC.
  2. Where the panelboard interrupting capacity is not indicated on the Contract Drawings, the circuit breaker interrupting capacity must be equal to or greater than the available fault current at the panelboard.
- C. Circuit Breakers, 200 A and Larger: Provide trip units interchangeable within frame size.
- D. Lugs: Provide mechanical lugs and power-distribution connectors for number per phase, size, and material of conductors indicated on Contract Drawings.
- E. Single Manufacturer: All circuit breakers and the panelboard in which the breakers are installed shall be products of the same manufacturer.
- F. Mains: Panelboards shall have either main lugs or main circuit protective device as scheduled.
- G. Replacement: Provide bolt-on circuit breakers, replaceable without disturbing adjacent units.
1. Branch circuits shall be connected to the individual circuit breakers as indicated on contract drawings.
- 2.04 ACCESSORY COMPONENTS AND FEATURES
- A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

### **PART 3 - EXECUTION**

#### **3.01 GENERAL**

- A. Comply with manufacturer's requirements in accordance with the direction of the WRPM.

#### **3.02 INSTALLATION**

- A. Materials: Materials provided in this Section shall be in accordance with FAA-C-1217, and FAA-STD-019.

- B. Mounting Heights: Install panelboards and accessory items according to NEMA PB 1.1 and with applicable codes at each location indicated on the plan. Mount the top of the panelboard trim at 78 inches from the ground, unless otherwise indicated.
- C. Mounting Tall Panelboards: Mount panelboards greater than 90 inches tall directly on the floor or maintenance pad, as shown on Contract Drawings.
- D. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
- E. Circuit Directory: Type directory to include installed circuit loads after balancing panelboard loads. The directory shall be arranged so that typed entries simulate circuit breaker positions in the panelboard. The directory shall be mounted on the inside of the door in a holder with a protective covering. Obtain approval from the WRPM before installing.
- F. Filler Plates: Provide and install filler plates for unused spaces in panelboards.
- G. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle with wire ties after completing load balancing.

### 3.03 IDENTIFICATION

- A. Component Identification: Identify field-installed wiring as specified in Section 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS.
- B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws, as specified in Section 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS.
- C. Warning Signs: Provide warning signs as specified in Section 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS.

### 3.04 GROUNDING:

- A. Termination: Terminate ground connections in panelboards in accordance with Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- B. Tightening Torque: Tighten electrical connectors and terminals, including ground connections, according to the manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.
- C. Ground Bus Bar: If ground bus bar is mounted to enclosure with screw threads only, (i.e. tapped blind hole), a separate bolted ground lug shall be installed on the panelboard and bonded to the ground bus bar.

### 3.05 FIELD QUALITY CONTROL

- A. Measure and record steady-state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 10 percent, rearrange circuits on the panelboards to balance the phase loads within 10 percent.



- B. Take care to maintain proper phasing for multi-wire branch circuits.
- C. Perform insulation-resistance megger tests of each panelboard bus, component, and connecting supply, feeder, and control circuits to main service ground.
- D. Make continuity and phasing tests of each circuit.
  - 1. Perform ground continuity tests on main electrical ground bus to inspect for physical damage, proper alignment, anchorage, and grounding.
- E. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.
- F. After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- G. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA, ATS, Section 7.5 for switches, and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
- H. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.
  - 1. Check each panelboard to ensure that it contains a minimum of 20 percent spare capacity for future use.
- I. Adjusting: Set field-adjustable switches and circuit breaker trip ranges as indicated.
- J. Cleaning: On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt and debris. Touch up scratches and marred finishes to match original finish.

**END OF SECTION**

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**SECTION 26 27 26****LOW VOLTAGE WIRING DEVICES****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes various types of receptacles, multi-outlet assemblies, lighting switches, and finish plates.
- B. Provide lighting switches, convenience and multi-outlet assemblies, special purpose receptacles, etc., along with appropriate outlet boxes, trim and finish plates, etc., as indicated on the drawings and schedules and as herein specified.
- C. Where connection to an item of equipment is required under this contract, and where such equipment requires a wiring device (special purpose receptacle) for connection, provide the appropriate device, whether or not the device is specifically shown or specified.

**1.02 REFERENCE STANDARDS**

- A. Applicable only to the extent specified.
  - 1. Federal Aviation Administration (FAA)
    - a. FAA-C-1217 Electrical Work, Interior, latest edition
    - b. FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment, latest edition
  - 2. Federal Specifications (FS)
    - a. W-C-596 General and Associated Detailed Specifications: Connector, Plug Receptacle, and Cable Outlet, Electrical Power
    - b. W-S-896E Switch, Toggle, Flush Mounted
  - 3. National Electrical Manufacturer Association (NEMA)
    - a. WD1 General Requirements for Wiring Devices
  - 4. National Fire Protection Association (NFPA)
    - a. 70 National Electrical Code (NEC), latest edition
  - 5. Occupational Safety and Health Administration (OSHA)
    - a. 29 CFR1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
  - 6. Underwriters Laboratories (UL)

- |    |     |   |
|----|-----|---|
| a. | 20  | General Use Snap Switches                   |
| b. | 498 | Electrical Attachment Plugs and Receptacles |
| c. | 943 | Ground Fault Circuit Interrupters           |

### 1.03 SUBMITTALS

- A. Parsons WRPM approval is required for all submittals. Submit the following:
1. Provide Component catalog numbers and manufacturer's data sheets, including pertinent data identifying each component by the item number and nomenclature, as specified.
  2. Operation and maintenance data for materials and products specified in this Section to be included in Section 26 05 00.10 BASIC ELECTRICAL MATERIALS AND METHODS.

### 1.04 QUALITY CONTROL

- A. Comply with NFPA 70, NEC, latest edition, for devices and installation.
- B. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.
1. The Terms "Listed" and "Labeled": As defined in the NEC," Article 100.
  2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.
- C. The manufacturer shall be a company specializing in the manufacturing products specified in this Section with a minimum of five (5) years experience.

### 1.05 COORDINATION:

- A. Wiring Devices for Government Furnished Equipment: Match devices to plug connectors for Government-furnished equipment.
- B. Device plates shall be stainless steel, brushed finish PRODUCTS.

## PART 2 - PRODUCTS

### 2.01 GENERAL:

- A. Materials procured and installed in this Section shall be in accordance with:
1. FAA-C-1217
  2. FAA-STD-019
- B. All wiring devices of any one general type (e.g. all duplex receptacles, all wall switches etc.) shall be of the same manufacturer and shall match throughout.

## 2.02 WIRING DEVICES

- A. Comply with NEMA Standard WD 1, "General Purpose Wiring Devices," and UL approved, specification grade.
- B. Enclosures: NEMA 1 equivalent, except as otherwise indicated. Exterior receptacles shall be mounted in waterproof cast outlet boxes with waterproof covers.
- C. Receptacles, General: All receptacles shall be specification grade in accordance with NEMA WD 1. Wiring terminals shall be of the screw-type. Receptacles with push-in connections or a combination of screw-type and push-in connectors are not acceptable.
- D. Straight-Blade: Except as otherwise indicated, comply with Federal Specification W-C-596 and heavy-duty grade of UL Standard 498, "Electrical Attachment Plugs and Receptacles." Provide NRTL labeling of devices to verify these compliances.
- E. General Purpose Duplex Receptacle: 125 volt, 20 Ampere, 2 pole, 3 wire grounded, with polarized slots, NEMA 5-20R.
- F. Ground-Fault Circuit Interrupter Receptacles: UL Standard 943, "Ground Fault Circuit Interrupters," feed-through type, with integral NEMA 5-20R (UL Group I, Class A), duplex receptacle arranged to protect connected downstream receptacles on the same circuit. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side or back wired with two screws per terminal. The grounding screw shall be connected to the metal mounting yoke.
- G. Weatherproof Receptacles shall be mounted in a box with a gasketed cover.
- H. Special Purpose or Heavy Duty Receptacles: Shall be of the type, rating and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle type plug of the same configuration shall be furnished with each receptacle.
- I. Wall Switches:
  - 1. Snap Switches: AC switches, NRTL listed and labeled as complying with UL Standard 20 "General Use Snap Switches", and with Federal Specification W-S-896E.
- J. Single-pole and three way wall switches shall be specification grade, 120/277 volts, and shall be fully rated 20 amperes AC only, totally enclosed toggle type with bodies of phenolic compound.
- K. Wire terminals shall be of the screw type.
- L. Switches with push-in connections or a combination of screw type and push-in connectors are not acceptable.
- M. Switches shall be the quiet-operating type.
- N. Switch handles shall be ivory in color.
- O. Devices and Devices Plates:
  - 1. Provide device plates of one-piece type to suit the devices installed.
  - 2. Plate screw shall be metal with countersunk head, in a color to match the finish of the plate.
  - 3. Provide device plates as follows:

- a. Brushed stainless steel in unfinished areas (e.g. ALSF Shelter).
  - b. Gasketed in wet locations.
- 4. Intercommunications outlets shall be provided with a blank cover plate unless otherwise indicated.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Arrangement of Devices: Except as otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on bottom. Group adjacent switches under single, multi-gang wall plates.
- B. Where two or more devices indicated for gang installation, they shall be trimmed with gang type plates. Sectional Plates are not acceptable.
- C. Install devices and assemblies tightly to boxes and adjusted plumb, level.
- D. Receptacles shall be installed 18 inches above finished floor, unless noted otherwise.
- E. Wall switches shall be installed 48 inches above finished floor, unless noted otherwise.
- F. Install receptacles with grounding pole on the bottom.
- G. Wall Switch Installation:
  - 1. Not more than one switch shall be installed in a single gang position.
  - 2. Grounding: Where switches have grounding terminals, they shall be grounded with a green grounding pigtail connected from the switch grounding screw directly to the grounding lug on the outlet box where the green equipment grounding conductor is terminated.
  - 3. Install switches with "Off" position down.
- H. Device Plate Installation:
  - 1. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without use of mats or similar devices.
  - 2. Plates installed in wet locations shall be gasketed.
  - 3. Use of sectional type device plates shall not be permitted.
  - 4. Plastic rings shall not be permitted.
  - 5. Install wall plates after painting is complete.
- I. Protect devices and assemblies during painting.
- J. Install products in accordance with the manufacturer's instructions.

### **3.02 IDENTIFICATION**

- A. Comply with Section 26 05 53 IDENTIFICATION OF ELECTRICAL SYSTEMS.

### 3.03 GROUNDING

- A. The green insulated equipment grounding conductor, run with the power conductors, shall terminate at the device yoke grounding screw. In addition to this ground connection, install a #12 AWG jumper from the device yoke grounding screw to device box grounding lug screw.

### 3.04 FIELD QUALITY CONTROL:

- A. Testing: Test wiring devices for proper polarity, continuity and operation.
- B. Test ground-fault circuit interrupter operation with both local and remote fault simulations according to manufacturer's recommendations.
- C. Test that each switch operates properly 6 times in succession.
- D. Verify that each receptacle device is energized.
- E. Replace damaged or defective components.

### 3.05 CLEANING

- A. General: Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

**END OF SECTION**

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**SECTION 26 28 16****ENCLOSED SWITCHES AND CIRCUIT BREAKERS****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes furnishing materials, equipment, labor, and incidentals necessary to install individually mounted disconnect switches and circuit breakers used for the following:
1. Feeder and equipment disconnect switches
  2. Feeder overcurrent protection
  3. Service

**1.02 REFERENCE STANDARDS**

- A. Applicable only to the extent specified.
1. Federal Aviation Administration
    - a. FAA-C-1217 Electrical Work, Premises Wiring, latest edition
    - b. FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment, latest edition
  2. Federal Specifications
    - a. W-C-375 Circuit Breakers, Molded Case, Branch Circuit and Service
    - b. W-S-865 Safety Switches
  3. International Electrical Testing Association (NETA)
    - a. ATS Acceptance Testing Specification for Electric Power Distribution Equipment and Systems
  4. National Electrical Manufacturer Association (NEMA)
    - a. KS 1 Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
    - b. FU 1 Low Voltage Cartridge Fuses
    - c. PB 1.2 Application for Ground Fault Protective Devices and Equipment
  5. National Fire Protection Association (NFPA)
    - a. National Electrical Code (NEC), latest edition
  6. Occupational Safety and Health Administration (OSHA)
    - a. 29CFR1910.7 Definitions and requirements for a Nationally Recognized Testing Laboratory (NRTL)

- B. Underwriters Laboratories (UL)
  - a. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

#### 1.03 SUBMITTALS

- A. Parsons WRPM approval is required for all submittals. Product Data for switches, circuit breakers and accessories specified in this Section. Include the following:
  - 1. Voltage rating
  - 2. Current trip rating
  - 3. Short circuit rating
  - 4. Fuse rating
  - 5. Type of enclosure
  - 6. Circuit frame size, trip rating, and number of poles
- B. Field test reports indicating and interpreting test results.
- C. Include outline drawings with dimensions and equipment ratings for voltage, capacity and short circuit.

#### 1.04 QUALITY CONTROL

- A. Single Source Responsibility: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.
- B. NFPA Compliance: Comply with NFPA 70 latest edition for components and installation.
- C. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

### PART 2 - PRODUCTS

#### 2.01 GENERAL

- A. Materials procured and installed in this Section shall be in accordance with FAA-C-1217H, and FAA-STD-019F.

#### 2.02 FUSES

- A. Refer to Section 26 28 13 FUSES for fuse requirements.

## 2.03 DISCONNECT SWITCHES

- A. General: Switches shall be heavy duty, fusible or non-fusible of the voltage, phase, and current ratings indicated on the Contract Drawings. Switches shall be the quick-make, quick-break type. Except for ground lugs which shall be bonded to the housing, parts shall be mounted on insulating bases to permit replacement of any part from the front of the switch. All current carrying parts shall be of high conductivity copper unless otherwise specified and shall be designed to carry rated current without excessive heating. Switch contacts shall be silver tungsten or plated to minimize corrosion, pitting and oxidation and to assure suitable conductivity. Switch handle shall be lockable in either the "ON" or "OFF" position.
  - 1. Provide lugs to accept more than one conductor per phase as required for application. Landing multiple conductors in a single lug is not acceptable.
  - 2. Provide 2 padlocks for each switch.
  - 3. Handle interlocked with cover in the "CLOSED" position.
- B. Enclosed, Non-fusible Switch: NEMA KS 1, Type HD
- C. Enclosed, Fusible Switch: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, and provide rejection type fuse clips with switches.
- D. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location:
  - 1. Outdoor Locations: Type 3R.
  - 2. Fabricate enclosure from steel.
  - 3. Finish using manufacturer's standard enamel finish, gray color.

## 2.04 MOLDED CASE CIRCUIT BREAKERS

- A. NEMA AB 1, UL 489, FS W-C-375, lockable handle, with 2 padlocks complying with FED SPEC W-C-375, and the following requirements:
  - 1. Molded case type.
  - 2. Quick make, quick break connections with mechanical trip, free switching mechanism
  - 3. Inverse time, thermal trip for overloads. Automatic release secured by bi-metallic thermal element releasing the mechanism latch. Thermal trip calibrated for 40 degree C ambient temperature.
  - 4. Magnetic armature shall be provided to trip the breaker instantaneously for short-circuit currents above the overload range.
  - 5. Automatic tripping shall be indicated by a handle position between the manual "OFF" and "ON" positions.
  - 6. Multi-phase circuit breakers shall have an internal, common trip mechanism to open all poles simultaneously.
  - 7. Circuit breaker shall have mechanical lugs and power distribution connectors sufficient for the number, size, and material of the conductors indicated. Provide lugs to accommodate multiple conductors per phase as required for application. Landing multiple conductors in a single lug is not acceptable.
  - 8. Include provisions for padlocking.
  - 9. Provide poles as indicated on Contract Drawings.
  - 10. Provide ratings as indicated on Contract drawings.
    - a. Minimum interrupt rating at 240V: 22,000 AIC symmetrical.
    - b. Voltage rating 120/240V.

- c. Current rating as indicated on Contract Drawings.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Verify that surfaces are ready to receive work.
- B. Verify field measurements are as shown on the drawings.
- C. Verify that required utilities are available, in proper location and ready for hookup.

### **3.02 INSTALLATION**

- A. Standards Compliance: Materials installed in this Section shall be in accordance with FAA-C-1217 and FAA-STD-019.
- B. Installation Location: Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's instructions and as required by the NEC and local codes.
- C. Installation Practice: Install disconnect switches level and plumb, and as required by the NEC and local codes.
- D. Circuit Connection: Connect disconnect switches, circuit breakers and components to wiring system and to ground as indicated and in accordance with manufacturer's recommendations.
- E. Torque Settings: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.
- F. Circuit Identification: Identify each disconnect switch and circuit breaker according to requirements specified in Section 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS.
- G. Fuse Installation: Install fuses in fused disconnect switches.
- H. Fuses: Refer to Section 26 28 13 FUSES for fuse requirements.
- I. Termination: Connecting more than one conductor to a phase lug is not acceptable.

### **3.03 FIELD QUALITY CONTROL**

- A. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- B. Procedures: Perform each visual and mechanical inspection and electrical tests stated in NETA ATS, Section 7.5 for disconnect switches, Section 7.6 and NEMA AB1 for molded-case circuit breakers. Certify compliance with test parameters.
- C. Correcting Malfunctions: Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

- D. Visual Inspection: Inspect visually and perform several "On-Off" operations on each circuit breaker.
- E. Circuit Continuity: Verify circuit continuity on each pole in the closed position.

#### 3.04 CLEANING

- A. After completing system installation, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches and abrasions.

**END OF SECTION**

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**SECTION 26 41 00****FACILITY LIGHTNING PROTECTION****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes the furnishing of labor, material, equipment and incidentals necessary to install a complete lightning protection system for buildings and associated structures and requirements for lightning protection system components in accordance with UL 96A, NFPA 780 and this specification.

**1.02 REFERENCE STANDARDS**

- A. Applicable only to the extent specified.
1. Federal Aviation Administration (FAA)
    - a. FAA-C-1217 Electrical Work, Premises Wiring, latest edition
    - b. FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment, latest edition
    - c. FAA-STD-020 Transient Protection, Bonding and Shielding Requirements for Equipment, latest edition
  2. National Fire Protection Association (NFPA)
    - a. 780 Lightning Protection Code
    - b. 70 National Electrical Code (NEC), latest edition
  3. National Institute of Standards and Technology (NIST)
  4. Occupational Safety and Health Administration (OSHA)
    - a. 29CFR1910.7 Definitions and Requirements for a Nationally Recognized Testing Laboratory (NRTL)
  5. Underwriters Laboratories (UL)
    - a. 96 Lightning Protection Components
    - b. 96A Installation Requirements for Lightning Protection Systems
  6. Lightning Protection Institute (LPI)
    - a. LPI-175 Lightning Protection Standard of Practice

**1.03 ACTION SUBMITTALS**

- A. Parsons WRPM approval is required for all submittals. Submit the following:

1. Product Data: Product Data for each component specified. Include the following:
  - a. Roof adhesive data.
  - b. Decorative air terminal illustrations.
2. Shop Drawings: Shop Drawings detailing the lightning protection system, including but not limited to type, size, air terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway and data on how concealment requirements will be met.
3. Qualification Data: Qualification data for firms and persons specified in the "Quality Assurance" article to demonstrate their capabilities and experience. Include data on listing or certification by nationally recognized testing laboratory (NRTL) or trade association. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
4. Product Certificates: Signed certification that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.
5. Field Test Reports: Field inspection reports indicating compliance with specified requirements.
6. Specifications: Manufacturer's product specifications.
7. Catalog Cuts: Product catalog cut sheets provided by the product manufacturer.

#### 1.04 QUALITY CONTROL

- A. Installer Qualifications: Engage an experienced installer who is certified by the Lightning Protection Institute as a Master Installer/Designer to install lightning protection system.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled by an organization concerned with product evaluations and that can determine compliance with appropriate standards for the current production of listed items.
  - a. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
  - b. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.
- C. NFPA Compliance: Comply with NFPA 70 "National Electrical Code," latest edition.
- D. UL Compliance: Conform to UL 96A and provide UL Master Label.
- E. Certification: Conform to the most stringent requirements of the following standards.
  1. LPI Certification of the System.
  2. ETL Master Label indicating system complies with specified requirements.

#### 1.05 SEQUENCING AND SCHEDULING

- A. Coordinate installation of lightning protection with installation of other building systems and components including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes, in accordance with FAA-STD-019.



## PART 2 - PRODUCTS

### 2.01 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Materials: All equipment shall be UL approved and marked in accordance with UL procedures. All equipment shall be new and of a design and construction to suit the application in accordance with UL 96A requirements. Bronze and stainless steel may be used for some components. Aluminum material shall not be in contact with copper material and bimetal connector shall be used for interconnecting copper and aluminum.
1. All materials shall be copper and bronze and of the size, weight and construction to suit the application where used in accordance with UL, NFPA, and NEC code requirements for this type structure and as per manufacturer's recommendation. Class II sized components may be utilized on roof levels 75 feet and below in height. With the exception of the cable holders, all connectors and splices utilize exothermic weld connections.
  2. Aluminum material may not be used except on roofs that require aluminum components in order to be compatible with aluminum roofing materials. In this case, mechanical connectors may be used. Suitable transition joints, properly installed by trained personnel are required between aluminum and copper conductors.
- B. Air Terminals: Air terminals shall meet the following requirements:
1. Air terminals shall be UL approved and shall be solid copper, aluminum or bronze. Copper air terminals may be nickel plated. The minimum sizes are 1/2 inch in diameter for solid copper or bronze air terminals, and 5/8 inch in diameter for solid aluminum air terminals. Air terminals shall be a minimum of 12 inches in height, and shall have a rounded or "bullet" tip.
  2. Air terminals shall be tapered to a blunt point and shall extend at least 10 inches above the object or area they are designed to protect. Wherever a risk of injury exists from falling and striking an air terminal, the tip of the air terminal shall be not less than 5 feet above the walking or working surface.
  3. Rod and support shall be designed to handle a 75 pounds per square foot wind load.
- C. Conductors: Conductors shall meet the following requirements:
1. All lightning protection conductors shall be sized in accordance with NFPA 780, Table 4.1.1.1.1 (a) "Minimum Class II Material Requirements."
  2. Copper conductors shall be manufactured of copper grade ordinarily required for commercial electrical work, designated as being 98 percent conductive when annealed.
  3. Down conductors shall be of copper cable and weigh not less the 375 pounds per 1000 feet and the size of any wire (strand) of this cable shall not be less than #15 AWG and shall be tinned.
  4. The thickness of any copper ribbon or strip shall not less than #17 AWG.
  5. Copper conductors used shall not be less than #15 AWG or as shown on the drawings.
  6. Conductors used for bonding these metallic bodies shall be Class II secondary conductors in accordance with NFPA 780.
- D. Hardware: Hardware shall meet the following requirements:
1. Fasteners: Fasteners shall be of the same material as the conductor base material or bracket being fastened, or other equally corrosion resistant material. Galvanized or plated materials shall not be used.
  2. Fittings: Bonding devices, cable splices, and miscellaneous connectors shall be suitable for use with the installed conductor with exothermic weld. Bolt pressure connections of

secondary conductors may be acceptable where indicated on drawings. Cast or stamped crimp type fittings shall not be used.

- E. Guards: Guards shall meet the following requirements:
1. Guards shall be provided for down conductors located in or next to driveways, walkways or other areas where they may be displaced or damaged.
  2. Guards shall extend to roof level, and 6 foot above and 1 foot below grade level.
  3. Guards shall be schedule 40 PVC where feasible.
  4. Metal guards may be used but shall be bonded to the down conductor at both ends.
  5. Bonding jumpers shall be of the same size as the down conductor.
  6. PVC guards do not require bonding.
  7. Crimp type connections shall not be used, only exothermic welds are acceptable.

### **PART 3 - EXECUTION**

#### **3.01 GENERAL**

- A. Comply with manufacturer's requirements in accordance with the direction of the WRPM.
- B. Examine surfaces and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of Lightning Protection System. Do not proceed with installation until unsatisfactory conditions have been corrected.
- C. The contract drawings indicate the extent and general arrangement of the Lightning Protection System.

#### **3.02 INSTALLATION**

- A. Installation standards: Installation shall conform to UL standard 96A. Installer shall provide an Underwriters' Laboratories Master Label for the facility. Installation shall also comply with NFPA 780, FAA C-1217, and FAA STD-019.
- B. Conform to the most stringent requirements when more than one standard is specified.
- C. Conductor and raceway routing: Down conductors shall maintain a horizontal or downward course. No bend in a roof or down conductor shall form an included angle of less than 90 degrees, nor shall it have a bend radius of less than 8 inches. Conductors shall be routed external to buildings and 6 feet or more from power or signal conductors.
- D. Down conductor terminations: Down conductors shall be used to ground air terminals conductors from 2 feet to 6 feet outside the foundation or exterior footing of a building. Down conductors shall be connected to the ground rods by exothermic welding. Provide number of down conductors indicated on drawings. Down conductors shall be routed outside of any structure and shall not penetrate or invade that structure. All down conductors except one may be provided with a screw type connector as described in UL 96 where lightning protection testing may be required. Down conductors shall be supported from and secured to the building exterior using one-hole straps of copper or bronze at maximum intervals of three (3) feet.
- E. Down conductor routing: Route down conductors outside of building facade in Schedule 80 PVC raceway. Submit system plan which indicates exact location of down conductors, as well as intended equipment locations, to WRPM for approval prior to installation.

- F. Air terminal attachment: Air terminals shall be located in accordance with the requirements of NFPA 780 and UL 96A. All air terminals shall be secured against overturning either by attachment to the object to be protected, or by means of braces that are permanently and rigidly attached to the building.
- G. Metallic bodies subject to induced charges: Metallic bodies, on or below roof level, that are subject to induced charges from lightning include exhaust fans, metal cooling towers, HVAC units, railings ladders, antennas, roof drains, plumbing vents, metal coping, metal flashing, downspouts, small wall vents, door and window frames, metal balcony railings and generally any isolated metallic body within 6 feet of an exposed lightning protection system element. These metallic bodies shall be bonded to the nearest main Lightning Protection System using UL approved splicers, fittings and conductors.
- H. Metallic bodies subject to direct lightning discharge: Metallic bodies on roofs subject to direct lightning discharge are generally any large metallic body whose size causes it to protrude beyond the zone of protection of the installed air terminals. This includes antenna support structures, exhaust fans, flues, ladders, railings, and roof hatches. When these metallic bodies have a metal thickness of 3/16 inches or greater, they shall be bonded to the nearest main lightning protection system conductor with UL approved fittings and conductors meeting the requirements of NFPA 780. These bonding fittings shall provide surfaces of not less than 3 square inches. Provisions shall be made to prevent corrosive effects introduced by galvanic action of dissimilar metals at bonding points. If the metal parts of these units are less than 3/16 inches thick, additional approved air terminals, conductors, and fittings, providing a two-way path to ground from the air terminals, shall be installed.

### 3.03 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.
- B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

### 3.04 FIELD QUALITY CONTROL

- A. Periodic inspections: Provide the services of a qualified inspector to perform periodic inspections during construction and at its completion, according to LPI-175.
- B. UL inspection: Apply for inspection by UL as required for UL Master Labeling of system.
- C. ETL inspection: Provide the services of ETL to inspect completed system for conformance with specified requirements.
- D. Periodic quality control testing: Establish and maintain quality control for the lightning protection system installation to assure compliance with contract requirements and shall maintain records of his quality control for all construction operations. WRPM shall furnish a copy of these records and tests, as well as the records of corrective action taken. Obtain an Underwriter's Laboratories Master Label for the facility.

### 3.05 TESTING

- A. Resistance-to-ground testing: Upon completion of installation of lightning protection system, test resistance-to-ground with resistance tester. Where tests show resistance-to-ground is over 5 ohms,

take appropriate action to reduce resistance to 5 ohms, or less, by treating soil proximity to ground rods with sodium chloride, copper sulfate, or magnesium. Retest to demonstrate compliance.

- B. Testing of the continuity of all conductors: A copy of these records and tests, as well as the records of corrective action taken shall be furnished to the WRPM.

**END OF SECTION**

## SECTION 26 43 13 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

### PART 1 - GENERAL

#### 1.01 SUMMARY

A. Section includes:

1. Type 1 surge protective devices.
2. Type 2 surge protective devices.
3. Enclosures.

B. Related Requirements:

1. Section 26 24 16 "Panelboards" for integral SPDs installed by panelboard manufacturer.
2. Section 26 27 26 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

#### 1.02 DEFINITIONS

A.  $I_n$ : Nominal discharge current.

B. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

#### 1.03 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

- a. Include electrical characteristics, specialties, and accessories for SPDs.
- b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:

- 1) Tested values for VPRs.
- 2)  $I_n$  ratings.
- 3) MCOV, type designations.
- 4) OCPD requirements.
- 5) Manufacturer's model number.
- 6) System voltage.
- 7) Modes of protection.

B. Field quality-control reports.

#### 1.04 INFORMATIONAL SUBMITTALS

A. Sample warranty.

## 1.05 WARRANTY

- A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.
1. Initial Extended Warranty Period: Five year(s) from date of Substantial Completion, for labor, materials, and equipment.
  2. Follow-On Extended Warranty Period: 10 year(s) from date of Substantial Completion, for materials only, f.o.b. the nearest shipping point to Project site.

## PART 2 - PRODUCTS

### 2.01 TYPE 1 SURGE PROTECTIVE DEVICES (SPDS)

- A. Source Limitations: Obtain devices from single source from single manufacturer.
- B. General Characteristics:
1. Reference Standards: UL 1449, Type 1.
  2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V power system.
  3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 160 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
  4. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
    - a. Line to Neutral: 700 V for 208Y/120 V.
    - b. Line to Line: 1200 V for 208Y/120 V.
  5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:
    - a. Line to Neutral: 700 V.
    - b. Line to Line: 1200 V.
  6. SCCR: Not less than 100 kA.
  7.  $I_n$  Rating: 20 kA.
- C. Options:
1. Include integral disconnect switch.
  2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  3. Include indicator light display for protection status.
  4. Include audible alarm.
  5. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
  6. Include surge counter.

## 2.02 TYPE 2 SURGE PROTECTIVE DEVICES (SPDS)

- A. Source Limitations: Obtain devices from single source from single manufacturer.
- B. General Characteristics:
  - 1. Reference Standards: UL 1449, Type 2; UL 1283.
  - 2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V power system.
  - 3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
  - 4. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
    - a. Line to Neutral: 700 V for 208Y/120 V.
    - b. Line to Ground: 700 V for 208Y/120 V.
    - c. Neutral to Ground: 700 V for 208Y/120 V.
    - d. Line to Line: 1200 V for 208Y/120 V.
  - 5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:
    - a. Line to Neutral: 700 V.
    - b. Line to Ground: 700 V.
    - c. Neutral to Ground: 700 V.
    - d. Line to Line: 1200 V.
  - 6. SCCR: Equal or exceed 100 kA.
  - 7.  $I_n$  Rating: 20 kA.
- C. Options:
  - 1. Include LED indicator lights for power and protection status.
  - 2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  - 3. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
  - 4. Include surge counter.

## 2.03 TYPE 3, TYPE 4, AND TYPE 5 SURGE PROTECTIVE DEVICES (SPDS)

- A. Type 3, Type 4, and Type 5 SPDs are not approved for field installation.

## 2.04 ENCLOSURES

- A. Indoor Enclosures: Type 1.
- B. Outdoor Enclosures: Type 3R.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

### **3.02 FIELD QUALITY CONTROL**

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
  - 1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
  - 2. Inspect anchorage, alignment, grounding, and clearances.
  - 3. Verify that electrical wiring installation complies with manufacturer's installation requirements.
- C. Nonconforming Work:
  - 1. SPDs that do not pass tests and inspections will be considered defective.
  - 2. Remove and replace defective units and retest.
- D. Prepare test and inspection reports.
- E. Manufacturer Services:
  - 1. Engage factory-authorized service representative to support field tests and inspections.

### **3.03 STARTUP SERVICE**

- A. Complete startup checks in accordance with manufacturer's instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

**END OF SECTION 26 43 13**



**SECTION 26 51 00****INTERIOR LIGHTING****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes furnishing labor, materials, equipment, and incidentals necessary to install interior luminaires, lamps, ballasts/drivers, exit signs, and accessories.

**1.02 REFERENCE STANDARDS**

- A. Applicable only to the extent specified.
1. American National Standards Institute (ANSI)
    - a. C62.41 Recommended Practice on Surge Voltage in Low-Voltage AC Power Circuits
    - b. C78.377 Specifications for the Chromaticity of Solid State Lighting Products
  2. Federal Specifications (FS)
    - a. W-L-305 Light Set, Emergency
    - b. J-C-30 Cable and Wire, Electrical
  3. Federal Aviation Administration (FAA)
    - a. FAA-C-1217 Electrical Work, Premises Wiring, latest edition
    - b. FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding, and Shielding Requirements for Facilities and Electronic Equipment, latest edition
  4. Military Standards
    - a. MIL STD-461 Requirements for Control of Electromagnetic Interference Emissions and Susceptibility User
  5. National Fire Protection Association (NFPA)
    - a. 70 National Electrical Code (NEC), latest edition
  6. Occupational Safety and Health Administration (OSHA)
    - a. 29CFR1910.7 Definition and Requirements for a National Recognized Testing Laboratories
  7. Underwriters Laboratories (UL)
    - a. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

- b. 924 Emergency Lighting and Power Equipment
- c. 8750 Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.

8. Illuminating Engineering Society (IES)

- a. IES HB-10 IES Lighting Handbook (2011; Errata 2015)
- b. IES LM-79 Electrical and Photometric Measurements of Solid-State Lighting Products (2008)
- c. IES LM-80 Measuring Lumen Maintenance of LED Light Sources (2015)
- d. IES RP-16 Nomenclature and Definitions for Illuminating Engineering (2017)
- e. IES TM-21 Projecting Long Term Lumen Maintenance of LED Light Sources (2011; Addendum B 2015)

9. National Electrical Manufacturers Association (NEMA)

- a. NEMA SSL 1 Electronic Drivers for LED Devices, Arrays, or Systems (2016)
- b. NEMA SSL 3 High-Power White LED Binning for General Illumination (2011)

10. Code of Federal Regulations (CFR)

- a. Title 47 Part 15 for Class A Devices
- b. Title 47 Part 15 for Class B Devices

1.03 DEFINITIONS

- A. Luminaire: A complete lighting unit or exit sign. Luminaires include lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply.
- B. Average Life: The time after which 50 percent fail and 50 percent survive under normal conditions.
- C. Luminaire: Luminaire.
- D. Luminaire Efficacy (LE): 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.

1.04 SUBMITTALS

- A. Parsons WRPM approval is required for all submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:
  - 1. Product Data: Submit product data describing luminaires, lamps, ballasts/drivers, support points, weights, accessories, exit, and emergency lighting units. Arrange product data for luminaires in order of luminaire designation. Include data on features, accessories, and the following:
    - a. Outline drawings indicating dimensions and principal features of luminaires, lamp and ballast/driver data, support points, weights and accessories for each luminaire type.
    - b. Electrical Ratings and Photometric Data: Certified results of independent laboratory tests for luminaires and lamps.
    - c. Manufacturer's installation instructions under general provisions.

2. Maintenance data for luminaires to include in the operation and maintenance manual.

#### 1.05 QUALITY ASSURANCE

- A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL.
- B. Listing and Labeling: Provide luminaires and accessory components that are listed and labeled for their indicated use and installation conditions on the Project.
  1. Special Listing and Labeling: Provide luminaires for use in damp or wet locations, and recessed in combustible construction that are specifically listed and labeled for such use. Provide luminaires for use in locations classified as hazardous that are listed and labeled for the specific hazard.
  2. The Terms "Listed" and "Labeled:" As defined in the National Electrical Code, Article 100, latest edition.
  3. Listing and Labeling Agency Qualifications: An NRTL as defined in OSHA Regulation 1910.7.
- C. Ballast/Driver Manufacturer's Qualifications: Acceptable Manufacturers shall be firms regularly engaged in the design, manufacture and testing of commercial or industrial lighting luminaires and ballasts/drivers for at least five years.
- D. Coordination: Coordinate luminaires, mounting hardware, and trim with ceiling system and other items, including work of other trades, required to be mounted on ceiling or in ceiling space.
- E. LED Driver and Dimming Switch Compatibility Certificate: Submit certification from the luminaire, driver, or dimmer switch manufacturer that ensures compatibility and operability between devices. It shall also meet the requirements of CFR Title 47 Part 15 for Class A and/or Class B devices.
- F. Luminaire Design Data:
  1. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified per the NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).
  2. Provide long term lumen maintenance projections for each LED luminaire in accordance with IES TM-21. Data used for projections must be obtained from testing in accordance with IES LM- 80.
- G. LED Light Source:
  1. IES LM-79 Test Report: Submit test report on manufacturer's standard production model luminaire. Include all applicable and required data as outlined under "14.0 Test Report" in IES LM-79.
  2. IES LM-80 Test Report: Submit report on manufacturer's standard production LED light source (package, array, or module). Include all applicable and required data as outlined under "8.0 Test Report" in IES LM-80.
  3. IES TM-21 Test Report: Submit test report on manufacturer's standard production LED light source (package, array or module). Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in IES TM-21.

#### 1.06 DELIVERY, HANDLING, AND STORAGE

- A. Ship light luminaires inside protective cartons and keep packaged until installed. Deliver lamps to job site in the original packaging case and sleeves.

#### 1.07 SITE CONDITIONS

- A. Provide cold weather ballasts/drivers in luminaires that are subject to temperatures below 32 degrees F.
- B. Provide special mounting, enclosures, and fire safety, as required by the codes having jurisdiction so that the integrity of the UL listed ceiling assemblies is maintained.
- C. Provide UL labels where luminaires are subject to moisture.
- D. Provide DL or WI labels on luminaires required for the location.

#### 1.08 EXTRA MATERIALS

- A. Furnish extra materials that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents as described below:
  - 1. Lamps: 1 lamp for every 10 of each type and rating installed. Furnish at least one of each type.
  - 2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Ballasts/Drivers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 4. Wire Guards: 1 for every 50 of each type installed. Furnish at least one of each type.

#### 1.09 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty – Ballasts/Drivers: Provide a written warranty signed by manufacturer and Subcontractor agreeing to replace ballasts/drivers against defects in material or workmanship for a period of five years from the date of Substantial Completion. Defective ballasts/drivers shall be replaced within the warranty period at no cost to the Government.
- C. LED Luminaire Warranty: Provide a written 5 year on-site replacement warranty for material, luminaire finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.
  - 1. Include finish warranty to include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
  - 2. Material warranty must include:
    - a. All drivers.
    - b. Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Materials procured and installed in this Section shall be in accordance with FAA-C-1217 and FAA-STD- 019.

### 2.02 LUMINAIRES, GENERAL

- A. Comply with the requirements specified in the Articles below and lighting luminaire schedule indicated on the Contract Drawings.
  - 1. Provide the lighting luminaires as specified and scheduled on the Contract Drawings.
  - 2. Substitutes: Luminaires specified in the lighting luminaire schedule on Contract Drawings establish a level of quality and appearance that any substituted luminaires must match or exceed. Submit substitutions for the specified luminaires to the WRPM for approval.
  - 3. All lighting luminaires shall be UL approved and shall bear the UL label.

### 2.03 LUMINAIRE COMPONENTS, GENERAL:

- A. Metal Parts: Free from burrs and sharp corners and edges.
- B. Sheet Metal Components: Steel, except as indicated. Components are formed and supported to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit re-lamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping and when secured in operating position.
- D. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.
  - 4. Laminated Silver Metallized Film: 90 percent.
- E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic except as otherwise indicated.
  - 1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
  - 2. Lens Thickness: 0.125 inch minimum, except where greater thickness is indicated.
- F. Wiring: Luminaire wiring shall be thermoplastic insulated copper, rated for 600 volts, in accordance with F.S. J-C-30 and the NEC.
- G. Flexible Raceway: Flexible metal raceway is permitted for concealed interior installations only.

## 2.04 SUSPENDED LUMINAIRE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as luminaire.
- B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy arranged to mount a single luminaire. Finish same as luminaire.
- C. Rod Hangers: 1/4-inch minimum diameter, cadmium-plated, threaded steel rod.
- D. Hook Hanger: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

## 2.05 LUMINAIRES

- A. UL 1598, NEMA C82.77, and UL 8750. Provide luminaires as indicated in luminaire schedule and NL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. Provide all luminaires of the same type by the same manufacturer. Luminaires must be specifically designed for use with the driver, ballast or generator and light source provided.
- 1. LED Luminaires: Provide luminaires complete with power supplies (drivers) and light sources. Provide design information including lumen output and design life in luminaire schedule on project plans for LED luminaires. LED luminaires must meet the minimum requirements in the following table:

LUMINAIRE TYPE	MINIMUM LUMINAIRE EFFICACY (LE)	MINIMUM COLOR RENDERING INDEX (CRI)
LED TROFFER - 1 x 4300 x 1200 2 x 2600 x 600 2 x 4600 x 1200	90 LPW	80
LED Downlight	50 LPW	90
LED Track or Accent	40 LPW	80
LED Low Bay/High Bay	80 LPW	70
LED Linear Ambient	80 LPW	80

- 2. LED luminaires must also meet the following minimum requirements:
  - a. Luminaires must have a minimum 5 year manufacturer's warranty.
  - b. Luminaires must have a minimum L70 lumen maintenance value of 50,000 hours as calculated by IES TM-21, with data obtained per IES LM-80 requirements.
  - c. Luminaire drive current value must be identical to that provided by test data for luminaire in question.
  - d. Luminaires must be tested to IES LM-79 and IES LM-80 standards, with the results provided as required in the Submittals paragraph of this specification.
  - e. Luminaires must be listed with the Design Lights Consortium 'Qualified Products List' when falling into category of "General Application" luminaires, i.e. Interior Directional, Display Case, Troffer, Linear Ambient, or Low/High Bay. Requirements are shown in the Design Lights Consortium "Technical Requirements Table" at <https://data.energy.gov/dataset/EPA-Recognized-Laboratories-ForLighting-Products/jgwf-7qrr>.

- f. Provide Department of Energy 'Lighting Facts' label for each luminaire.

## 2.06 LED DRIVERS

- A. NEMA SSL 1, UL 8750. LED drivers must be electronic, UL Class 1, constant-current type and comply with the following requirements:
  - 1. Output power (watts) and luminous flux (lumens) as shown in luminaire schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.
  - 2. Power Factor (PF) greater than or equal to 0.9 over the full dimming range when provided.
  - 3. Current draw Total Harmonic Distortion (THD) of less than 20 percent.
  - 4. Class A sound rating.
  - 5. Operable at input voltage of 120-277 volts at 60 hertz.
  - 6. Minimum 5 year manufacturer's warranty.
  - 7. RoHS compliant.
  - 8. Integral thermal protection that reduces or eliminates the output power if case temperature exceeds a value detrimental to the driver.
  - 9. UL listed for dry or damp locations typical of interior installations.
  - 10. Non-dimmable or fully-dimmable using 0-10V control as indicated in luminaire schedule.

## 2.07 EXIT LIGHTS

- A. Conform to UL 924 "Emergency Lighting and Power Equipment," and the following:
  - 1. Sign Colors: Conform to local code.
  - 2. Minimum Height of Letters: Conform to local code.
  - 3. Arrows: Include as indicated.
  - 4. Lamps for AC Operation: Light Emitting Diode (LED) array.

## 2.08 EMERGENCY LIGHTING

- A. Conform to UL924 "Emergency Lighting and Power Equipment," and Federal Specification W-L-305, Type I, Class 1, Style D or E, with the number of heads as indicated on the drawings and the following:
  - 1. Housing: Retractable with flush mounted door.
  - 2. Power Supply: Remote nickel cadmium battery pack.
  - 3. Integral Test Module: Self diagnostic monitoring system.
  - 4. Finish: white powder coat finish to be custom painted to match surrounding finishes in the field.
  - 5. Power Cord: No more than three feet in length, plugged in to a single-gang receptacle (or hard wired).
  - 6. Connect to the same branch circuits that provide normal lighting to the area, ahead of any local switches.

## 2.09 FINISHES

- A. Manufacturer's standard finish applied over corrosion-resistant treatment or primer, free of streaks, runs, stains, blisters, and similar defects. Remove luminaires showing evidence of corrosion during project warranty period and replace with new luminaires.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Installation of lighting systems shall be in accordance with FAA C-1217 and FAA STD-019.

### **3.02 INSTALLATION**

- A. Installation: Install lamps in luminaires and lamp holders and set units plumb, square and level with ceilings and walls, and secure according to manufacturer's written instructions and approved Shop Drawings.
- B. Finishes: Check the architectural finishes and provide luminaires with proper trim, frames, and other hardware required to coordinate with the proper finishes, regardless of the specified or scheduled catalog numbers, prefixes and suffixes.
- C. Emergency Luminaires: All emergency lighting luminaires shall be (plug-in or hardwired).
- D. Recessed Lighting: Install recessed lights to permit removal from below. Install gird clips.
- E. Hardware: Install straps, mounting plates, nipples, and/or brackets for proper installation.

### **3.03 CONNECTIONS AND GROUNDING**

- A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not specified, use those specified in UL 486A. Ground luminaires in accordance with FAA-C-1217, paragraph 4.4.5.2.
- B. External bonding jumpers are not required across flexible metal raceway.

### **3.04 FIELD QUALITY CONTROL**

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Give advance notice of dates and times for field tests.
- C. Provide instruments to make and record test results.
- D. Tests: Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. All luminaires shall be energized upon completion of installation for a period of 72 hours, upon which contractor shall replace any lamps or ballasts which are not operating properly.
- E. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.
- F. Report results of all tests.



- G. Replace luminaires that show evidence of corrosion during Project warranty period.

### 3.05 ADJUSTING AND CLEANING

- A. Immediately before final inspection clean luminaires inside and out including plastics and glassware. Use methods and materials recommended by manufacturer.
- B. Adjust all trim, aim luminaires in the presence of the WRPM to provide required light intensities.
- C. Touch up luminaire finish at the completion of the work.
- D. Replace broken or damaged parts.
- E. Lamp and test all luminaires for electrical, as well as mechanical operation.
- F. Re-lamp luminaries that have failed at completion of work.
- G. Align luminaries and clean lenses and diffusers at completion of the work. Clean paint splatters, dirt, and debris from installed luminaries.

**END OF SECTION**

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**SECTION 28 46 21.11****ADDRESSABLE FIRE-ALARM SYSTEMS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Addressable fire-alarm system.
  - 2. Fire-alarm control unit (FACU).
  - 3. Manual fire-alarm boxes.
  - 4. System smoke detectors.
  - 5. Heat detectors.
  - 6. Multicriteria and multisensor fire detectors.
  - 7. Fire-alarm notification appliances.
  - 8. Fire-alarm addressable interface devices.
  - 9. Digital alarm communicator transmitters (DACTs).
  - 10. Fire-alarm radio transmitters.
- B. Related Requirements:
  - 1. Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for cables and conductors for fire-alarm systems.

**1.02 DEFINITIONS**

- A. DACT: Digital alarm communicator transmitter.
- B. EMT: Electrical metallic tubing.
- C. FACU: Fire-alarm control unit.
- D. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
- E. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).
- F. NICET: National Institute for Certification in Engineering Technologies.
- G. PC: Personal computer.
- H. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
  - 1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
  - 2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

### 1.03 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. When new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.
- C. The building is an active surveillance facility. A detailed work plan shall be submitted to the SSC and approved by the SSC prior to any work in the equipment or communication rooms. Care shall be taken to mitigate risk of any falling debris into any equipment.
- D. Provide all design, materials, tools, equipment, installation and testing necessary for a complete and usable system conforming to the applicable requirements of NFPA, 70, NFPA 72, IBC and this specification. At a minimum, provide new devices as identified herein, shown on the contract drawings, where required by the referenced codes and standards and as well as manufacturer specific requirements. Where any conflicts between specification, applicable codes and drawings arise, the most stringent standard shall be applied. Or the installer shall inform the EOR immediately and request clarification.

### 1.04 ACTION SUBMITTALS

- A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect. Submitted drawings and documents by the contractor shall be provided as a single submission. Separate submittals will not be accepted. If this is not practical, include letter of explanation with each submittal. All required information to form a complete system design package in accordance with NFPA 72 shall be submitted together for approval by the FAA Resident Engineer (RE).
- B. Product Data: For each type of product, including furnished options and accessories.
  - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- C. Shop Drawings: For fire-alarm system.
  - 1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
  - 2. Name of protected premises, location, owner and occupant.
  - 3. Name and contact information of installer or contractor.
  - 4. Device legend and symbols in accordance with NFPA 170.
  - 5. Include plans, elevations, sections, and details, including details of attachments to other Work.
  - 6. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
  - 7. Detail assembly and support requirements.
  - 8. Include voltage drop calculations for notification-appliance circuits.
  - 9. Include battery-size calculations.
  - 10. Include conduit fill calculations.
  - 11. Include input/output matrix.
  - 12. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.

13. Include performance parameters and installation details for each detector.
  14. Provide control wiring diagrams for all fire-alarm interface devices.
    - a. Locate detectors in accordance with manufacturer's written instructions.
  15. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
  16. Submit a complete list of device addresses.
- D. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed by qualified NICET Level IV technician responsible for their preparation.
1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
  2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
  3. Indicate audible appliances required to produce square wave signal per NFPA 72.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Certificates:
1. Seismic Performance Certificates: For FACU, accessories, and components, from manufacturer. Include the following information:
    - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
- B. Field quality-control reports.
- C. Qualification Statements: For Installer.
- D. Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

#### 1.06 CLOSEOUT SUBMITTALS

- A. Submit an electronic copy of the Operation and Maintenance Data Manuals, indexed in booklet form: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Manuals shall be approved prior to training.
1. In addition to items specified in Section 01 77 00 "Closeout Procedures," include the following and deliver copies to authorities having jurisdiction when required:
    - a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
    - b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
    - c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
    - d. Riser diagram.
    - e. Device addresses.

- f. Record copy of site-specific software.
- g. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
  - 1) Equipment tested.
  - 2) Frequency of testing of installed components.
  - 3) Frequency of inspection of installed components.
  - 4) Requirements and recommendations related to results of maintenance.
  - 5) Manufacturer's user training manuals.
- h. Manufacturer's required maintenance related to system warranty requirements.
- i. Abbreviated operating instructions for mounting at FACU and each annunciator unit.

B. Software and Firmware Operational Documentation:

- 1. Software operating and upgrade manuals.
- 2. Program Software Backup: On USB media or approved online or cloud solution.
- 3. Device address list.
- 4. Printout of software application and graphic screens.

#### 1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- 1. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
  - 2. Smoke Detectors, Fire Detectors : Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
  - 3. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
  - 4. Keys and Tools: One extra set for access to locked or tamperproofed components.
  - 5. Audible and Visual Notification Appliances: One of each type installed.
  - 6. Fuses: Two of each type installed in system. Provide in box or cabinet with compartments marked with fuse types and sizes.

#### 1.08 QUALITY ASSURANCE

A. Installer Qualifications:

- 1. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
- 2. Installation must be by personnel certified by NICET as fire-alarm Level III technician.
- 3. Obtain certification by NRTL in accordance with NFPA 72.
- 4. Licensed or certified by authorities having jurisdiction.

#### 1.09 TRAINING

- A. The fire alarm contractor shall provide adequate training to permit programming control level function on the FACU and adequately monitor the system for the FAA Facilities Maintenance Personnel (FMP) and shall include the FMP personnel during all commissioning activities on-site to allow FMP to become familiarized with the system and components. This shall be at no additional cost to the FAA.

## 1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Furnish a list electronically and provide a hard copy (to be kept in spare parts cabinet), of all parts and accessories which the manufacturer of the system recommends to be stocked for maintenance.

## PART 2 - PRODUCTS

### 2.01 ADDRESSABLE FIRE-ALARM SYSTEM

- A. Description:
  - 1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn-and-strobe notification for evacuation.
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.
  - 2. General Characteristics:
    - a. Automatic sensitivity control of certain smoke detectors.
    - b. Fire-alarm signal initiation must be by one or more of the following devices :
      - 1) Manual stations.
      - 2) Heat detectors.
      - 3) Smoke detectors.
      - 4) Fire-extinguishing system operation.
    - c. Fire-alarm signal must initiate the following actions:
      - 1) Continuously operate alarm notification appliances.
      - 2) Identify alarm and specific initiating device at FACU.
      - 3) Transmit alarm signal to remote alarm receiving station.
      - 4) Record events in system memory.
    - d. Supervisory signal initiation must be by one or more of the following devices and actions:
      - 1) Valve supervisory switch.
      - 2) Low-air-pressure switch of clean agent storage system.
      - 3) Independent fire-detection and -suppression systems.
      - 4) Zones or individual devices have been disabled.
    - e. System trouble signal initiation must be by one or more of the following devices and actions:
      - 1) Open circuits, shorts, and grounds in designated circuits.
      - 2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
      - 3) Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
      - 4) Loss of primary power at FACU.
      - 5) Ground or single break in internal circuits of FACU.
      - 6) Abnormal ac voltage at FACU.
      - 7) Break in standby battery circuitry.
      - 8) Failure of battery charging.

- 9) Abnormal position of switch at FACU or annunciator.
- f. System Supervisory Signal Actions:
  - 1) Identify specific device initiating event at FACU.
  - 2) Transmit system status to building management system.
- g. Document Storage Box:
  - 1) Description: Enclosure to accommodate standard 8-1/2-by-11 inch manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
  - 2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
  - 3) Color: Red powder-coat epoxy finish.
  - 4) Labeling: Permanently screened with 1 inch high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
  - 5) Security: Locked with 3/4 inch barrel lock. Provide solid 12 inch stainless steel piano hinge.

## 2.02 FIRE-ALARM CONTROL UNIT (FACU)

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Notifier; Honeywell International, Inc.
    - a. A Notifier NFS-320 shall be provided for this project.
      - 1) Panel shall be rated for clean agent releasing applications.
- B. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.
- C. Performance Criteria:
  - 1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
  - 2. General Characteristics:
    - a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
    - b. Include real-time clock for time annotation of events on event recorder and printer.
    - c. Provide communication between FACU and remote circuit interface panels, annunciators, and displays.
    - d. FACU must be listed for connection to central-station signaling system service.
    - e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACU must provide minimum 500-event history log.
    - f. Addressable Initiation Device Circuits: FACU must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
      - 1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: FACU must be listed for releasing service.
    - g. Fire-Alarm Annunciator: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
      - 1) Annunciator and Display: LCD, 80 characters, minimum.
      - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.
    - h. Alphanumeric Display and System Controls: Arranged for interface between human operator at FACU and addressable system components including annunciation and



supervision. Display alarm, supervisory, and component status messages and programming and control menu.

- 1) Annunciator and Display: LCD, two line(s) of 40 characters, minimum.
- 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.

i. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

- 1) Pathway Class Designations: NFPA 72, Class A.
- 2) The separation of outgoing and return for Class A circuits as detailed in the annex material of NFPA 72 Chapter A.12.3.8 shall be applicable.
  - a) Exception, the emergency living quarters building is allowed not to have separation because it qualifies under A.12.3.8.1(3).
- 3) Pathway Survivability: Level 0.
- 4) Install no more than 50 addressable devices on each signaling-line circuit.
- 5) Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.

j. Serial Interfaces:

- 1) One dedicated RS 485 port for central-station operation using point ID DACT.
- 2) One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).

k. Notification-Appliance Circuit:

- 1) Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72.
- 2) Where notification appliances provide signals to sleeping areas, alarm signal must be 520 Hz square wave with intensity 15 dB above average ambient sound level or 5 dB above maximum sound level, or at least 75 dB(A-weighted), whichever is greater, measured at pillow.
- 3) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.

l. Remote Smoke-Detector Sensitivity Adjustment: Controls must select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out final adjusted values on system printer.

m. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.

n. Primary Power: 24 V(dc) obtained from 120 V(ac) service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, digital alarm radio transmitters must be powered by 24 V(dc) source.

o. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.

p. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.

q. Batteries: Sealed lead calcium.

D. Accessories:

1. Instructions: Computer printout or typewritten instruction card mounted behind plastic or glass cover in stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe functional operation of system under normal, alarm, and trouble conditions.

## 2.03 MANUAL FIRE-ALARM BOXES

- A. Notifier NBG-12 series addressable pull station.
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
  - 1. Double-action mechanism requiring two actions to initiate alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
  - 2. Station Reset: Key- or wrench-operated switch.
  - 3. Material: Manual stations made of Lexan polycarbonate.
  - 4. Able to be used in indoor areas.

## 2.04 SYSTEM SMOKE DETECTORS

- A. Photoelectric Smoke Detectors:
  - 1. Notifier FPTI-951 Multi-criteria detector.
  - 2. Performance Criteria:
    - a. Regulatory Requirements:
      - 1) NFPA 72.
      - 2) UL 268.
    - b. General Characteristics:
      - 1) Detectors must be two-wire type.
      - 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
      - 3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
      - 4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
      - 5) Integral Visual-Indicating Light: LED type, indicating detector has operated.
      - 6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
      - 7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
        - a) Primary status.
        - b) Device type.
        - c) Present average value.
        - d) Present sensitivity selected.
        - e) Sensor range (normal, dirty, etc.).
      - 8) Color: White.
      - 9) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 15 or 20 deg F per minute.
      - 10) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 or 155 deg F.
      - 11) Multiple levels of detection sensitivity for each sensor.

## 2.05 MULTICRITERIA AND MULTISENSOR FIRE DETECTORS

- A. Notifier FPTI-951

- B. Description: Fire-sensing detectors using multiple means of detection.
- C. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. NFPA 72.
  - 2. General Characteristics:
    - a. Mounting: Twist-lock base interchangeable with smoke-detector bases.
    - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
    - c. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. Detector must send trouble alarm if it is incapable of compensating for existing conditions.
    - d. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
      - 1) Primary status.
      - 2) Device type.
      - 3) Present sensitivity selected.
      - 4) Sensor range (normal, dirty, etc.).
    - e. Color: White.
    - f. Comply with UL and FM Global requirements.
    - g. Sensors (Multisensor Type): Detector must be comprised of three sensing elements including smoke sensor, infrared sensor, and heat sensor.
      - 1) Smoke sensor must be photoelectric type as described in "System Smoke Detectors" Article.
      - 2) Each sensor must be separately listed in accordance with requirements for its detector type.

## 2.06 FIRE-ALARM NOTIFICATION APPLIANCES

- A. Fire-Alarm Audible Notification Appliances:
  - 1. System Sensor:
    - a. L-Series horn/strobes (indoor)
    - b. Outdoor rated horn/strobes (outdoor)
  - 2. Description: Horns, bells, or other notification devices that cannot output voice messages.
  - 3. Performance Criteria:
    - a. Regulatory Requirements:
      - 1) NFPA 72.
    - b. General Characteristics:
      - 1) Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
      - 2) Sounders, High Volume 24 V(dc): 90.0 mA of alarm current.
      - 3) ISO Temporal 3 Evacuation Tone: 82 dBA at 24 V.
      - 4) Horns: Electric-vibrating-polarized type, 24 V(dc); with provision for housing operating mechanism behind grille. Comply with UL 464. Horns must produce sound-pressure level of 82 dB(A-weighted), measured 10 ft. from horn, using coded signal prescribed in UL 464 test protocol.
      - 5) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- B. Fire-Alarm Visible Notification Appliances:
  - 1. System Sensor L-Series Strobes.
  - 2. Performance Criteria:

- a. Regulatory Requirements:
  - 1) NFPA 72.
  - 2) UL 1971.
- b. General Characteristics:
  - 1) Rated Light Output:
    - a) 15/30/75/110 cd, selectable in field.
  - 2) Clear polycarbonate lens.
  - 3) Mounting: Wall mounted unless otherwise indicated.
  - 4) Flashing must be in temporal pattern, synchronized with other units.
  - 5) Strobe Leads: Factory connected to screw terminals.
  - 6) Mounting Faceplate: Factory finished, red.

## 2.07 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

- A. Notifier
  - 1. FMM-1(A)
  - 2. FRM-1(A)
  - 3. XP6-R(A)
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. NFPA 72.
  - 2. General Characteristics:
    - a. Include address-setting means on module.
    - b. Store internal identifying code for control panel use to identify module type.
    - c. Listed for controlling HVAC fan motor controllers.
    - d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
    - e. Integral Relay: Capable of providing direct signal fan shutdown.
      - 1) Allow control panel to switch relay contacts on command.
      - 2) Have minimum of two normally open and two normally closed contacts available for field wiring.
    - f. Control Module:
      - 1) Operate solenoids for use in sprinkler service.

## 2.08 DIGITAL ALARM COMMUNICATOR TRANSMITTERS (DACTS)

- A. Compatible with operation of Notifier NFS-320 control panel.
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. NFPA 72.
  - 2. General Characteristics:
    - a. DACT must be acceptable to remote central station and must be listed for fire-alarm use.
    - b. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU and automatically using cellular communications. When contact is made with central station(s), signals must be transmitted. If service is interrupted for longer than 45 seconds, transmitter must initiate local trouble signal and transmit signal indicating loss of service. Transmitter must automatically report service restoration to central station.
    - c. Local functions and display at DACT must include the following:
      - 1) Verification that cellular service is available.

- 2) LED display.
  - 3) Manual test report function and manual transmission clear indication.
  - 4) Communications failure with central station or FACU.
- d. Digital data transmission must include the following:
  - 1) Address of alarm-initiating device.
  - 2) Address of supervisory signal.
  - 3) Address of trouble-initiating device.
  - 4) Loss of ac supply.
  - 5) Loss of power.
  - 6) Low battery.
  - 7) Abnormal test signal.
  - 8) Communication bus failure.
- e. Secondary Power: connection to FACU batteries is allowed.
- f. Self-Test: Conducted automatically less than every 60 minutes with report transmitted to central station.

## 2.09 OVERVOLTAGE AND SURGE SUPPRESSION

- A. For systems having circuits located outdoors and primary power connections, communications equipment shall be protected against surges induced on circuit and shall comply with the applicable requirements of IEEE C62.41.0. Surge Suppression shall be provided between all cable lines and all cable lines to ground. Fuses shall not be used for surge suppression. Cables and conductors that serve as communication links between structures, shall have surge protection installed wherever circuits enter/leave a structure that meets the following specifications:
  - 1. Suppressor shall be rated for the voltage of the line connected conductors.
  - 2. A 10 microsecond by 100 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
  - 3. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
  - 2. Verify that work plan is approved.
  - 3. Verify that FOD protective measures are installed over equipment.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.

- B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service in accordance with requirements indicated:
  - 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of fire-alarm service.
  - 2. Do not proceed with interruption of fire-alarm service without Construction Manager's and Owner's written permission.
- C. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

### 3.03 INSTALLATION OF EQUIPMENT

- A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
  - 1. Devices placed in service before other trades have completed cleanup must be replaced.
  - 2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
  - 1. Connect new equipment to new cellular communicator.
  - 2. Connect new equipment to existing ERMS Panel and coordinate identification of signals.
- C. Install wall-mounted equipment, with tops of cabinets not more than 64 inch above finished floor.
- D. Manual Fire-Alarm Boxes:
  - 1. Install manual fire-alarm box in normal path of egress within 60 inch of exit doorway.
  - 2. Mount manual fire-alarm box on background of contrasting color.
  - 3. Operable part of manual fire-alarm box must be between 42 and 48 inch above floor level. Devices must be mounted at same height unless otherwise indicated.
- E. Smoke- and Heat-Detector Spacing:
  - 1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
  - 2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
  - 3. Smooth ceiling spacing must not exceed 30 ft..
  - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A in NFPA 72.
  - 5. HVAC: Locate detectors not closer than 36 inch from air-supply diffuser or return-air opening.
  - 6. Lighting Fixtures: Locate detectors not closer than 12 inch from lighting fixture and not directly above pendant mounted or indirect lighting.
- F. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.
- G. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within dwelling or suite, they must be connected so that operation of smoke alarm causes alarm in smoke alarms to sound.

- H. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- I. Audible Alarm-Indicating Devices: Install not less than 6 inch below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.
- J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch below ceiling. Install devices at same height unless otherwise indicated.
- K. Device Location-Indicating Lights: Locate in public space near device they monitor.
- L. Antenna for Cellular Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists wind load of 100 mph with gust factor of 1.3 without damage.

### 3.04 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
  - 2. Nameplate must be laminated acrylic or melamine plastic signs with black background and engraved white letters at least 1/2 inch high.

### 3.05 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 26 27 26 "Low Voltage Wiring Devices."
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

### 3.06 PATHWAYS

- A. Raceways above recessed ceilings and in inaccessible locations may be routed exposed.
  - 1. Exposed pathways located less than 96 inch above floor must be installed in EMT.
- B. Pathways must be installed in EMT.
- C. Exposed EMT must be painted red enamel.

### 3.07 CONNECTIONS

- A. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inch from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
  - 1. Interface with ERMS panel

### 3.08 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals.
- B. Install framed instructions in location visible from FACU.

### 3.09 GROUNDING

- A. Ground FACU and associated circuits in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Ground shielded cables at control panel location only. Insulate shield at device location.

### 3.10 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by EOR and FAA RE.
- B. Adminstrant for Tests and Inspections:
  - 1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
  - 2. Administer and perform tests and inspections.
- C. Tests and Inspections:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
    - b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.
  - 2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
  - 4. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
  - 5. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
  - 6. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.



- D. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

### 3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Provide video recording of training to Owner.

### 3.12 MAINTENANCE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
  - 1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

### 3.13 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement must include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.
  - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

**END OF SECTION 28 46 21.11**



**SECTION 31 05 19.13****GEOTEXTILES FOR EARTHWORK****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Nonwoven geotextile material.

**1.02 REFERENCE STANDARDS**

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
- B. ASTM International:
  - 1. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
  - 2. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
  - 3. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
  - 4. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
  - 5. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
  - 6. ASTM D4833/D4833M - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
  - 7. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
  - 8. ASTM D4884/D4844M - Standard Test Method for Strength of Sewn or Bonded Seams of Geotextiles.
  - 9. ASTM D4886 - Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).

**1.03 ACTION SUBMITTALS**

- A. Product Data: Submit manufacturer information including tensile strength, elongation, thickness, UV resistance, and other material specifications.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- C. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- D. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

#### 1.04 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of geotextile material, including placement depth.

#### 1.05 QUALITY ASSURANCE

- A. Perform Work according to State of Arkansas Department of Transportation standards.

#### 1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Comply with ASTM D4873.
- C. Store materials according to manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to manufacturer instructions.

### PART 2 - PRODUCTS

#### 2.01 NONWOVEN GEOTEXTILE MATERIALS

- A. Furnish materials according to State of Arkansas Department of Transportation standards.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Verify that underlying surface is smooth and free of ruts or protrusions that could damage geotextile material.

### 3.02 PREPARATION

- A. Subgrade Material and Compaction Requirements: As specified in Section 31 20 00-Earthmoving.

### 3.03 INSTALLATION

#### A. Geotextile Material:

1. Lay and maintain smooth and free of tensile stresses, folds, wrinkles, or creases.
2. Ensure that material is in direct contact with subgrade.
3. Orientate with long dimension of each sheet parallel to direction of slope.
4. Minimum Unseamed Joints Overlap: 18 inches.

#### B. Securement Pins:

1. Insert through geotextile midway between edges of overlaps and minimum 6 inches from free edges.
2. Minimum Spacing:
  - a. Slopes Steeper than 3 Horizontal on 1 Vertical: 24 inches o.c.
  - b. Slopes 3 Horizontal on 1 Vertical to 4 Horizontal on 1 Vertical: 3 feet o.c.
  - c. Slopes Flatter than 4 Horizontal on 1 Vertical: 5 feet o.c.
3. Ensure that washer bears against geotextile.

#### C. Seams:

1. Minimum Seamed Joints Overlap: 12 inches at longitudinal and transverse joints.
2. Seams across Slope: Lap upper panel over lower panel.
3. Sewn Seams:
  - a. Continuously sew seams on slopes steeper than 1 vertical on 3 horizontal.
  - b. Stitch Type: As recommended by geotextile manufacturer.
  - c. Tie off thread at the end of each seam to prevent unraveling.
4. Thermal Seams:
  - a. As recommended by geotextile manufacturer.
  - b. Comply with ASTM D4886.

#### D. Penetrations: As recommended by geotextile manufacturer.

#### E. Repairing Damaged Geotextiles:

1. Repair torn or damaged geotextile by placing patch of same type of geotextile over damaged area minimum of 12 inches beyond edge of damaged area and fasten as recommended by geotextile manufacturer.
2. Remove and replace geotextile rolls which cannot be repaired.

#### F. Fill and Cover:

1. Place fill to prevent tensile stress or wrinkles in geotextile.
2. Place fill from bottom of side-slopes upward.

3. Do not drop fill from height greater than 3 feet.

#### 3.04 PROTECTION

- A. Ballast: Adequate to prevent uplift of material by wind.
- B. UV Exposure: Do not leave material uncovered for more than 14 days after installation.
- C. Do not use staples or pins to hold geotextiles in place where located adjacent to other geosynthetic layers that could be damaged.
- D. Do not operate equipment directly on top of geotextile.

**END OF SECTION**

**SECTION 31 10 00****SITE CLEARING****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Removing surface debris.
2. Removing designated trees, shrubs, and other plant life.
3. Removing abandoned utilities.
4. Removing fence and gate.
5. Excavating topsoil.
6. Removing existing aggregate surface.

**B. Related Sections:**

1. Section 02 41 16 - Structure Demolition: Removing underground storage tanks and designated utilities.

**1.02 ACTION SUBMITTALS**

- A. Product Data: Submit data for herbicide. Indicate compliance with applicable codes for environmental protection.

**PART 2 - EXECUTION****2.01 EXAMINATION**

- A. Verify existing plant life designated to remain is tagged or identified.

**2.02 PREPARATION**

- A. Call Local Utility Line Information service at 811 not less than three working days before performing Work.
1. Request underground utilities to be located and marked within and surrounding construction areas.

**2.03 PROTECTION**

- A. Locate, identify, and protect from damage utilities indicated to remain.
- B. Protect benchmarks, survey control points, and existing structures from damage or displacement.

## 2.04 CLEARING

- A. Clear undergrowth and deadwood, without disturbing subsoil.

## 2.05 REMOVAL

- A. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.
- B. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.
- C. Do not burn or bury materials on site. Leave site in clean condition.

## 2.06 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be further excavated, relandscaped, or regraded, without mixing with foreign materials for use in finish grading.
- B. Do not excavate wet topsoil.
- C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion. Stockpile material on impervious material, until disposal.
- D. Remove excess topsoil not intended for reuse, from Site.
- E. Remove topsoil from Site.
- F. Do not remove topsoil from Site.

**END OF SECTION**



**SECTION 31 20 00****EARTH MOVING****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Excavating and filling for rough grading the site.
2. Preparing subgrades for slabs-on-grade, sidewalks, and gravel or asphalt pavement surfacing.
3. Excavating and backfilling for buildings and structures.
4. Subbase course for concrete sidewalks.
5. Excavating and backfilling trenches for utilities and pits for buried utility structures.

**1.02 REFERENCES****A. The current issues of the following documents in effect on the date of the request-for proposal form a part of this specification and are applicable to the extent specified herein. Unless otherwise indicated on the Construction Drawings or herein specified, all work under this Section shall be performed in accordance with the current State Department of Transportation Standard Specifications for Construction of Roads and Bridges.****B. American Society of Testing and Materials (ASTM) Publications:**

1. ASTM D-2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
2. ASTM D-4253 Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
3. ASTM D-4254 Test Methods for Minimum Index Density of Soils and Calculations of Relative Density.
4. ASTM D 6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
5. ASTM D-448 Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
6. ASTM D-698 Standard Test Methods for Laboratory Compaction Characteristics for Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
7. ASTM D-1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.
8. ASTM D-1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).
9. ASTM D-2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
10. ASTM D-4253 Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
11. ASTM D-4254 Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density.
12. ASTM D-4829 Standard Test Method for Expansion Index of Soils.
13. ASTM D 6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

### 1.03 DEFINITIONS

- A. Satisfactory Materials: Satisfactory materials comprise any materials classified by ASTM D2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC, SW-SC, SP-SM, SP-SC. (For SM and SC soils, the material finer than the No. 200 sieve shall be less than 30 percent.) As noted per the Geotechnical report.

1. Satisfactory materials for grading comprise stones less than 3 inches.

- B. Unsatisfactory Materials: Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter.

Cohesionless and Cohesive Materials: Cohesionless materials include materials classified in ASTM D2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C136/C136M and ASTM D1140. As noted per the Geotechnical report.

- C. Unstable Material: Unstable materials are too wet to properly support the utility pipe, conduit, or appurtenant structure. Unstable material shall be processed and recompact to the specified compaction condition. If, as determined by the Contracting Officer, the appropriate efforts have been made and materials are still unstable, the material shall be undercut until stable materials are encountered.

- D. Select Granular Material: by ASTM D2487 where indicated.

The liquid limit of such material must not exceed 45 percent when tested in accordance with ASTM D4318.

The plasticity index must not be greater than 20 percent when tested in accordance with ASTM D4318, and not more than 35 percent by weight may be finer than No. 200 sieve when tested in accordance with ASTM D1140.

Initial Backfill Material: Initial backfill consists of select granular material or satisfactory materials free from rocks 3 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, free the initial backfill material of stones larger than 2 inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

- E. Expansive Soils: Expansive soils are defined as soils that have a plasticity index equal to or greater than 15 when tested in accordance with ASTM D4318.
- F. Backfill: Soil material or controlled low-strength material used to fill an excavation.
1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- G. Base Course: Aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete walk.
- H. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- I. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

- J. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect/Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit price.
  2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
  3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- K. Fill: Soil materials used to raise existing grades.
- L. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cubic yard for bulk excavation or  $\frac{3}{4}$  cubic yard for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
  2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.
- M. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- N. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- O. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

#### 1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct pre-excavation conference at Project site.
1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
    - a. Personnel and equipment needed to make progress and avoid delays.
    - b. Coordination of Work with utility locator service.
    - c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
    - d. Extent of trenching by hand or with air spade.
    - e. Field quality control.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
  - 1. Warning tapes.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Material Test Reports: For each borrow soil material proposed for fill and backfill as follows:
  - 1. Classification according to ASTM D2487.
- C. Blasting with explosives is not permitted.
- D. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.07 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.
- C. Do not commence earth-moving operations until temporary site fencing and erosion- sedimentation-control measures shown on construction drawings are in place.
- D. The following practices are prohibited within protection zones:
  - 1. Impoundment of water.
  - 2. Excavation or other digging unless otherwise indicated.
- E. Do not direct vehicle or equipment exhaust towards protection zones.
- F. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

## PART 2 - PRODUCTS

### 2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 100 percent passing a 3-inch sieve, between 100 percent and 50 percent passing a No. 4 sieve and between 50 percent and 20 percent passing a No. 200 sieve. A liquid limit of 45 maximum, plasticity index of 20 maximum and Maximum Expansive Index (per ASTM D 4829) of 20 maximum. Additional requirements per geotechnical report.
- F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- G. Gravel Surface Course: ARDOT Class 7 Aggregate Base Course.
- H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.
- I. Sand: ASTM C33/C33M; fine aggregate.
- J. Berm and Drainage Swale Material: ARDOT Class 3 Aggregate.

### 2.02 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
  - 1. Red: Electric.
  - 2. Yellow: Gas, oil, steam, and dangerous materials.
  - 3. Orange: Telephone and other communications.

- 4. Blue: Water systems.
- 5. Green: Sewer systems.

### **PART 3 - EXECUTION**

#### **3.01 PREPARATION**

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

#### **3.02 DEWATERING**

- A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
- B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
- D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.
- E. Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein.
- F. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

### 3.03 EXPLOSIVES

- A. Explosives: Do not use explosives.

### 3.04 EXCAVATION, GENERAL

- A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock.
  - 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.
    - a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
  - 2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
    - a. 24 inches outside of concrete forms other than at footings.
    - b. 12 inches outside of concrete forms at footings.
    - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
    - d. 6 inches beneath bottom of concrete slabs-on-grade.
    - e. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

### 3.05 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
  - 1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

### 3.06 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### 3.07 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
  - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
  - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
  - 1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
  - 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
  - 3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
  - 4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

### 3.08 EXCAVATION FOR DITCHES, GUTTERS AND CHANNEL CHANGES

- A. Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown on the drawings. Do not excavate ditches and gutters below grades shown.
- B. Backfill the excessive open ditch or gutter excavation with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown.
- C. Dispose excavated material as shown or as directed, except in no case allow material to be deposited a maximum 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

### 3.09 EXCAVATION FOR DRAINAGE STRUCTURES

- A. Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown.
- B. Do not disturb the bottom of the excavation when concrete or masonry is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete or masonry is to be placed.
- C. Where pile foundations are to be used, stop the excavation of each pit at an elevation 1 foot above the base of the footing, as specified, before piles are driven.



- D. After the pile driving has been completed, remove loose and displaced material and complete excavation, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry.

### 3.10 SUBGRADE INSPECTION

- A. Notify Engineer when excavations have reached required subgrade.
- B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 25 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
  - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
  - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

### 3.11 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.
  - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

### 3.12 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.13 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
  - 1. Surveying locations of underground utilities for Record Documents.
  - 2. Testing and inspecting underground utilities.
  - 3. Removing concrete formwork.
  - 4. Removing trash and debris.

5. Removing temporary shoring, bracing, and sheeting.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

### 3.14 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Roadways: Provide 6-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 6 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

F. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

### 3.15 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.

2. Under walks and pavements, use satisfactory soil material.

3. Under steps and ramps, use engineered fill.

4. Under building slabs, use engineered fill.

5. Under footings and foundations, use engineered fill.

6. Fill for excavated underground structures, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

### 3.16 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

### 3.17 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact earth fill and cohesive aggregate materials to not less than the following percentages of maximum dry unit weight as determined by ASTM D-698 (Compact ARDOT aggregate base per ASTM D-1557), using nuclear methods:
  - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
  - 2. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
  - 3. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.
  - 4. Compact cohesionless aggregate fill on which it is not practical to control the density by "Proctor" methods to a minimum of 75% of relative density as determined by ASTM D- 4253 and D-4254, by a field compaction mold method correlated to ASTM D-4253 and D-4254. Compact cohesionless aggregate fill at a moisture content within a range that accommodates consistent placement and compaction to the minimum relative density specified above.

### 3.18 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - 1. Provide a smooth transition between adjacent existing grades and new grades.
  - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
  - 1. Turf or Unpaved Areas: Plus or minus 1 inch.
  - 2. Walks: Plus or minus 1 inch.
  - 3. Pavements: Plus or minus 1/2 inch.

- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/4 inch when tested with a 10-foot straightedge.

### 3.19 BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place base course under pavements and walks as follows:
  - 1. Shape base course to required crown elevations and cross-slope grades.
  - 2. Place base course 6 inches or less in compacted thickness in a single layer.
  - 3. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  - 4. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

### 3.20 GRAVEL SURFACE COURSE

- A. Place gravel surface course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place gravel surface course in conformance to cross sections, lines and elevations as indicated on construction drawings.

### 3.21 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, ASTM D1557, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:
  - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests. At least one per day for each day of paving.
  - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
  - 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests for each trench.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

### 3.22 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
  - 1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

### 3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

**END OF SECTION**

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**SECTION 31 37 16.13****RUBBLE-STONE RIPRAP****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes: Riprap placed loose.

**1.02 COORDINATION**

- A. Coordinate Work of this Section with rough grading, excavating, utilities, and related Work.

**1.03 PREINSTALLATION MEETINGS**

- A. Commence minimum one week prior to commencing Work of this Section.

**1.04 ACTION SUBMITTALS**

- A. Product Data: Submit manufacturer information regarding size distribution and types for rock for riprap.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

**1.05 QUALITY ASSURANCE**

- A. Furnish each aggregate material from single source throughout Work of this Section.
- B. Perform Work according to State of Arkansas Department of Transportation standards.

**PART 2 - PRODUCTS****2.01 MATERIALS**

- A. Riprap:
  - 1. Description:
    - a. Irregular-shaped rock.
    - b. Solid and nonfriable.
  - 2. Type: Granite.
- B. Furnish materials according to State of Arkansas Department of Transportation standards.

## **PART 3 - EXECUTION**

### **3.01 APPLICATION**

- A. Place riprap where indicated on Drawings.
- B. Place riprap into position and remove foreign material from surfaces.
- C. Do not place riprap over frozen or spongy subgrade surfaces.
- D. Average Installed Thickness: 12 inches.

### **3.02 ATTACHMENTS**

- A. Sloped Grade at Retaining Wall: Individual riprap units, 6-inch thickness; placed prior to finish topsoil.

**END OF SECTION**



## SECTION 32 05 16 - AGGREGATES FOR EXTERIOR IMPROVEMENTS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Coarse aggregate materials.
  - 2. Fine aggregate materials.

#### 1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
  - 2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
  - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 2. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction
  - 3. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>).
  - 4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>).
  - 5. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  - 6. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

#### 1.03 ACTION SUBMITTALS

- A. Materials Source: Submit name of imported materials suppliers.
- B. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

#### 1.04 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.
- B. Perform Work in accordance with State of Arkansas Highways

## **PART 2 - PRODUCTS**

### **2.01 COARSE AGGREGATE MATERIALS**

- A. Coarse Aggregate Type: Conforming to State of Arkansas Highways standard.

### **2.02 FINE AGGREGATE MATERIALS**

- A. Fine Aggregate Type: Conforming to State of Arkansas Highways standard.

### **2.03 SOURCE QUALITY CONTROL**

- A. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D698.
- B. Fine Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D698.
- C. When tests indicate materials do not meet specified requirements, change material and retest.

## **PART 3 - EXECUTION**

### **3.01 STOCKPILING**

- A. Stockpile materials on site at locations designated by Architect/Engineer.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.
- D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

### **3.02 STOCKPILE CLEANUP**

- A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

**END OF SECTION 32 05 16**

## SECTION 32 31 13.53 - HIGH-SECURITY CHAIN LINK FENCES AND GATES

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. High-security chain-link fences.
  - 2. Swing gates.
  - 3. Soil sterilization.

#### 1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
  - 2. Review coordination of soil sterilization with work specified elsewhere.
  - 3. Review coordination of interlocked equipment specified in this Section and elsewhere.
  - 4. Review required testing, inspecting, and certifying procedures.

#### 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    - a. Fence and gate posts, rails, and fittings.
    - b. Chain-link fabric, reinforcements, and attachments.
    - c. Accessories: Barbed wire .
    - d. Gates and hardware.
- B. Shop Drawings: For each type of fence and gate assembly.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Include accessories, hardware, gate operation, and operational clearances.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of chain-link fence and gate. Soil-sterilization certificate of treatment stating materials and quantities used, and date of application.
- B. Product Test Reports: For framework strength in accordance with ASTM F1043, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Field quality-control reports.

- D. Sample Warranty: For special warranty.

#### 1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

#### 1.06 FIELD CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

#### 1.07 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of high-security chain-link fences and gates that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure to comply with performance requirements.
    - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 2. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

#### 2.02 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in height measured between top and bottom of outer edge of selvage in accordance with "CLFMI Product Manual" and requirements indicated below:
  - 1. Fabric Height: One piece as indicated on Drawings.
    - a. Steel Wire for Fabric: Wire diameter of 0.192 inch.
      - 1) Mesh Size: 2 inches.
  - 2. Zinc-Coated Fabric: ASTM A392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied before weaving.

3. Zn-5Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F1345, Type III, Class 2, 1.0 oz./sq. ft..
4. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.
5. Selvage: Twisted and barbed top and bottom.

## 2.03 SECURITY FENCE FRAMEWORK

- A. Posts and Rails : ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts.

1. Fence Height: 96 inches.

## 2.04 TENSION WIRE

- A. Metallic-Coated Steel Wire: 0.177-inch- diameter, marcelled tension wire in accordance with ASTM A817 or ASTM A824, with the following metallic coating:

1. Type II: Zinc coated (galvanized) by electrolytic process, with Class 5 minimum coating weight of not less than 2.0 oz./sq. ft. of uncoated wire surface.

## 2.05 SWING GATES

- A. General: ASTM F900 for gate posts and single swing gate types.

1. Gate Leaf Width: As indicated.
2. Framework Member Sizes and Strength: Based on gate fabric height as indicated.

- B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; protective coating and finish to match fence framework.
2. Revise "Gate Posts" and "Gate Frames and Bracing" subparagraphs below if size of members is critical. See ASTM F900.
3. Gate Posts: Round tubular steel.
4. Gate Frames and Bracing: Round tubular steel.

- C. Frame Corner Construction: Welded and 3/8-inch- diameter, adjustable truss rods for panels 60 inches or wider.

- D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend as indicated above top of chain-link fabric at both ends of gate frame as required to attach barbed wire assemblies.

- E. Hardware:

1. Hinges: 360-degree inward and outward swing.
2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Closer: Manufacturer's standard.

## 2.06 FITTINGS

- A. Provide fittings in accordance with ASTM F626.
- B. Post Caps: Provide for each post.
  - 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
  - 1. Top-Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
  - 2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.
- E. Tension and Brace Bands, Tension Bars, and Truss Rod Assemblies: In accordance with ASTM F2611.
- F. Barbed Wire Arms: Pressed steel or cast iron, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts, for each post unless otherwise indicated, and as follows:
  - 1. Provide line posts with arms that accommodate top rail or tension wire.
  - 2. Provide corner arms at fence corner posts unless extended posts are indicated.
  - 3. Double-Arm Type: Type III, V-shaped arm.
  - 4. Use bolts or rivets for connection to posts.
- G. Tie Wires, Clips, and Fasteners: In accordance with ASTM F626.
  - 1. High-Security Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:
    - a. Metallic-Coated Steel: 0.148-inch- diameter wire; zinc coating.
    - b. Stainless steel.
- H. Power-Driven Fabric Fasteners: As recommended in writing by manufacturer.
- I. Finish:
  - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. of zinc.
    - a. Polymer coating over metallic coating.
  - 2. Aluminum: Mill finish.

## 2.07 BARBED WIRE

- A. Steel Barbed Wire: ASTM A121, High Security Grade, two-strand barbed wire; 0.099-inch- diameter line wire with 0.080-inch- diameter, four-point round barbs spaced not more than 3 inches o.c.
  - 1. Aluminum Coating: Type A.

## 2.08 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

## 2.09 GROUNDING MATERIALS

- A. Comply with requirements in Section 26 05 26 "Grounding and Bonding."
- B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.
  - 1. Connectors for Below-Grade Use: Exothermic welded type.
  - 2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

## 2.10 SOIL-STERILIZATION MATERIALS

- A. Soil Sterilant: Commercial herbicide for weed control, approved by authorities having jurisdiction.
- B. Polyethylene Sheeting: 6 mils thick, black, and serving as soil-separation fabric.
- C. Stone Ground Cover: Random-size range of 3/4- to 2-inch crushed stone or washed gravel.

# PART 3 - EXECUTION

## 3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
  - 1. Do not begin installation before final grading is completed unless otherwise permitted by Engineer.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.02 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

### 3.03 INSTALLATION OF CHAIN-LINK FENCING

- A. Install chain-link fencing in accordance with ASTM F567 and more stringent requirements specified.
  - 1. Install fencing on established boundary lines inside property line.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
- D. Terminal Posts: Install terminal end, corner, and gate posts in accordance with ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more, at any abrupt change in grade, and at intervals not greater than 500 feet. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.
- E. Line Posts: Space line posts uniformly at 96 inches o.c.
- F. Post Bracing and Intermediate Rails: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
  - 1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- G. Barbed Wire Arms: Bolt or rivet to top of post. Angle single arms away from approach side of fence.
- H. Tension Wire: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
  - 1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.
  - 2. Extended along top of barbed wire arms and top of fence fabric to support barbed tape.
- I. Top Rail: Install in accordance with ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- J. Bottom Rails: Secure to posts with fittings; anchor rail at midspan to concrete footing.
- K. Chain-Link Fabric: Apply fabric on the approach side of fence, inside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.



- L. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.
- M. Tie Wires: Power-fastened or manually fastened ties configured to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends one and one-half machine twists or three full manual twists, and cut off protruding ends to preclude untwisting by hand.
  - 1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- N. Power-Fastening of Fabric: Fasten 0.192- or 0.148-inch wire fabric with 2- or 1-inch mesh size. Fasten fabric to line posts 12 inches o.c. and to braces 24 inches o.c.
- O. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- P. Barbed Wire: Install barbed wire uniformly spaced as indicated on Drawings. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

### 3.04 INSTALLATION OF GATES

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

### 3.05 GROUNDING AND BONDING

- A. Comply with requirements in Section 26 05 26 "Grounding and Bonding."
- B. Fence and Gate Grounding:
  - 1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
  - 2. Install ground rods and connections at maximum intervals of 100 feet.
  - 3. Ground fence on each side of gates and other fence openings.
    - a. Bond metal gates to gate posts.
    - b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.
- C. Connections:
  - 1. Make connections with clean, bare metal at points of contact.
  - 2. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
  - 3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  - 4. Make above-grade ground connections with mechanical fasteners.
  - 5. Make below-grade ground connections with exothermic welds.
  - 6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

- D. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor in accordance with NFPA 780.
- E. Comply with requirements in Section 26 41 13 "Lightning Protection for Structures."

### 3.06 SOIL STERILIZATION

- A. Apply soil sterilant according to manufacturer's written instructions.
- B. Apply sterilant after completing grounding and other below-grade electrical work along fence line and within zone between double-row chain-link fence installation.
- C. Polyethylene Sheeting: Install sheeting continuously between double-row chain-link fence installation, overlapping edges and punctures 6 inches.
- D. Stone Ground Cover: Lay continuous 3-inch- deep bed of stone ground cover over polyethylene sheeting.
- E. Extent: Extend soil sterilization 48 inches beyond outside and inside of fence.

### 3.07 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests.
- B. Perform the following tests:
  - 1. Fabric Testing: Test fabric tension according to "Deflection Limits" Paragraph in "Performance Requirements" Article.
  - 2. Fence Post Rigidity Testing: Test line posts for rigidity according to "Deflection Limits" Paragraph in "Performance Requirements" Article.
  - 3. Grounding Tests: Comply with requirements in Section 26 41 13 "Lightning Protection for Structures."
- C. Prepare test reports.

### 3.08 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

### 3.09 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain high-security chain-link fences and gates.

END OF SECTION 32 31 13.53

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