



University of Colorado  
Colorado Springs

NATIONAL  
CYBERSECURITY  
CENTER

CORE AND SHELL PACKAGE





University of Colorado – Colorado Springs

**National Cybersecurity Center  
Core & Shell**

100% Construction Documents

**Project Manual**

November 22, 2016



## **PROJECT INFORMATION**

### **PROJECT IDENTIFICATION**

- A. Project Name: University of Colorado – Colorado Springs – National Cybersecurity Center – Core & Shell; located at:  
3650 North Nevada Avenue,  
Colorado Springs, Colorado
- B. The Owner, hereinafter referred to as UCCS.

### **PROJECT DESCRIPTION**

- A. Summary Project Description: Work will be contained to the south building, including the connecting corridors. Replacement of existing storefront vestibule entries and exterior windows. Enhance exterior walls to comply with the latest energy code. Two new toilet rooms. New heating and cooling equipment. New electric switch gear. Basic plumbing improvements including new toilet room fixtures.

### **PROJECT CONSULTANTS**

- A. The Architect, hereinafter referred to as Architect: CSNA Architects.  
532 North Tejon Street.  
Colorado Springs, Colorado 80903.  
(719) 473-7225.
- B. Structural Engineer: HCDA Engineering, Inc.  
545 East Pikes Peak Avenue, Suite 100  
Colorado Springs, Colorado 80903  
(719) 633-7784
- C. Mechanical Engineer: Bridgers & Paxton  
1365 Garden of the Gods Road, Suite 130  
Colorado Springs, Colorado 80907  
(719) 630-3350
- D. Electrical Engineer: Bridgers & Paxton  
1365 Garden of the Gods Road, Suite 130  
Colorado Springs, Colorado 80907  
(719) 630-3350



## CERTIFICATIONS PAGE

ARCHITECT

CSNA Architects

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Architect under the laws of the State of Colorado.

---

Gregory Friesen

Reg. No. ????????

December ??, 2016

Phone 719-473-7225

STRUCTURAL ENGINEER

HCDA Engineering, Inc.

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Colorado.

---

Name Andy Baturvech

Reg. No. ????????

December ??, 2016

Phone 719-633-7784





MECHANICAL ENGINEER

Bridgers & Paxton

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Colorado.

---

Steve Taylor

Reg. No. ????????

December ??, 2016

Phone 719-630-3350

ELECTRICAL ENGINEER

Bridgers & Paxton

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Colorado.

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Mark Bankson

Reg. No. ????????

December ??, 2016

Phone 719-630-3350



# TABLE OF CONTENTS

FOR

## PROJECT MANUAL

FOR

### UNIVERSITY OF COLORADO – COLORADO SPRINGS NATIONAL CYBERSECURITY CENTER

## CORE AND SHELL

### 100% CONTRACT DOCUMENTS

PROJECT NO. 1601916

**November 22, 2016**

#### **SPECIFICATIONS**

##### **DIVISION 01 -- GENERAL REQUIREMENTS**

- 01 10 00 - Summary
- 01 21 00 - Allowances
- 01 22 00 - Unit Prices
- 01 23 00 - Alternates
- 01 30 00 - Administrative Requirements
- 01 33 00 - Submittal Procedures
- 01 40 00 - Quality Requirements
- 01 41 00 - Regulatory Requirements
- 01 42 19 - Reference Standards
- 01 50 00 - Temporary Facilities and Controls



- 01 51 00 - Temporary Utilities
- 01 60 00 - Product Requirements
- 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions
- 01 70 00 - Execution and Closeout Requirements
- 01 78 00 - Closeout Submittals
- 01 79 00 - Demonstration and Training

**DIVISION 02 -- EXISTING CONDITIONS**

- 02 41 00 - Demolition

**DIVISION 03 -- CONCRETE**

- 03 01 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 05 13 - Shop-Applied Metal Finishes
- 05 50 00 - Metal Fabrications
- 05 52 13 - Pipe and Tube Railings

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

- 06 10 00 - Rough Carpentry
- 06 82 00 - Glass Fiber Reinforced Plastic

**DIVISION 07 -- THERMAL AND MOISTURE PROTECTION**

- 07 21 00 - Thermal Insulation
- 07 21 29 - Sprayed Insulation
- 07 25 00 - Weather Barriers
- 07 42 13 - Metal Wall Panels
- 07 62 00 - Sheet Metal Flashing and Trim
- 07 84 00 - Firestopping
- 07 92 00 - Joint Sealants

**DIVISION 08 -- OPENINGS**

- 08 11 13 - Hollow Metal Doors and Frames
- 08 14 16 - Flush Wood Doors
- 08 31 00 - Access Doors and Panels
- 08 33 23 - Overhead Coiling Doors



08 43 13 - Aluminum-Framed Storefronts

08 71 00 - Door Hardware

08 71 13 - Power Door Operators

08 80 00 - Glazing

**DIVISION 09 -- FINISHES**

09 05 61 - Common Work Results for Flooring Preparation

09 05 62 - Remedial Floor Coating

09 21 16 - Gypsum Board Assemblies

09 30 00 - Tiling

09 65 00 - Resilient Flooring

09 91 13 - Exterior Painting

09 91 23 - Interior Painting

**DIVISION 10 -- SPECIALTIES**

10 14 00 - Signage

10 21 13.13 - Metal Toilet Compartments

10 28 00 - Toilet, Bath, and Laundry Accessories

10 44 00 - Fire Protection Specialties

**DIVISION 11 -- EQUIPMENT (NOT USED)**

**DIVISION 12 -- FURNISHINGS**

12 32 16 - Manufactured Plastic-Laminate-Faced Casework

12 36 00 - Countertops

12 48 13 - Entrance Floor Mats and Frames

**DIVISION 13 -- SPECIAL CONSTRUCTION (NOT USED)**

**DIVISION 14 -- CONVEYING EQUIPMENT (NOT USED)**

**DIVISION 21 -- FIRE SUPPRESSION**

21 05 00 - Common Work Requirements for Fire Suppression

21 05 01 - Demolition for Fire Suppression

21 05 03 - Trenching and Backfill for Fire Suppression

21 05 04 - Pipe and Pipe Fittings for Fire Suppression

21 05 23 - Valves for Fire Suppression

21 05 49 - Fire Suppression and Electrical Installation Coordination

21 13 13 - Fire Protection System, Automatic Wet-Pipe Sprinkler





**DIVISION 22 -- PLUMBING**

- 22 05 00 - Common Work Requirements for Plumbing
- 22 05 01 - Demolition for Plumbing
- 22 05 03 - Trenching and Backfill for Plumbing
- 22 05 04 - Pipe and Pipe Fittings for Plumbing
- 22 05 05 - Piping Specialties for Plumbing
- 22 05 23 - Valves for Plumbing
- 22 05 49 - Plumbing and Electrical Installation Coordination
- 22 07 00 - Plumbing Insulation
- 22 11 00 - Domestic Water Piping
- 22 11 23 - Facility Natural Gas System
- 22 13 16 - Sanitary Waste and Vent Piping
- 22 40 00 - Plumbing Fixtures and Trim

**DIVISION 23 -- HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)**

- 23 05 00 - Common Work Requirements for HVAC
- 23 05 01 - Demolition
- 23 05 03 - Trenching and Backfilling
- 23 05 04 - Pipe and Pipe Fittings
- 23 05 05 - Piping Specialties
- 23 05 23 - Valves
- 23 05 49 - HVAC and Electrical Installation Coordination
- 23 05 50 - Variable Frequency Drives
- 23 05 93 - Testing, Adjusting and Balancing of Mechanical Systems
- 23 07 00 - Mechanical Systems Insulation
- 23 09 00 - Facility Management System
- 23 21 13 - Heating Hot Water System and Equipment
- 23 21 14 - Chilled Water System and Equipment
- 23 30 00 - Air Tempering System and Equipment
- 23 52 16 - Condensing Boilers
- 23 64 26 - Variable Speed Air Cooled Screw Water Chillers
- 23 73 13 - Central Station Air Handler
- 23 82 39.13 - Cabinet Unit Heaters
- 23 82 39.16 - Propeller Unit Heaters

**DIVISION 26 -- ELECTRICAL**

- 26 05 00 - Common Work Results for Electrical
- 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- 26 05 23 - Control-Voltage Electrical Power 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 44 - Sleeves and Sleeve Seals for Electrical Raceways and Cabling
- 26 05 53 - Identification for Electrical Systems



26 05 73 - Overcurrent Protective Device Coordination Study  
26 05 74 - Overcurrent Protective Device Arc-Flash Study  
26 09 23 - Lighting Control Devices  
26 22 00 - Low-Voltage Transformers  
26 24 13 - Switchboards  
26 24 16 - Panelboards  
26 27 26 - Wiring Devices  
26 28 13 - Fuses  
26 28 16 - Enclosed Switches and Circuit Breakers  
26 29 13 - Enclosed Controllers  
26 51 19 - LED Interior Lighting  
26 52 19 - Emergency and Exit Lighting

**DIVISION 27 -- COMMUNICATIONS (NOT USED)**

**DIVISION 28 -- ELECTRONIC SAFETY AND SECURITY (NOT USED)**

**DIVISION 31 -- EARTHWORK**

31 10 00 - Site Clearing

**DIVISION 32 -- EXTERIOR IMPROVEMENTS**

32 12 16 – Asphalt Paving  
32 13 13 – Concrete Paving  
32 17 23.13 - Painted Pavement Markings  
32 84 23 – Underground Sprinklers  
32 92 23 - Sodding

**DIVISION 33 -- UTILITIES (NOT USED)**



**SECTION 01 10 00  
SUMMARY**

**PART 1 GENERAL**

**1.01 PROJECT**

- A. Project Name: UCCS - North Nevada Tenant Building Renovation - Core & Shell
- B. UCCS's Name: University of Colorado - Colorado Springs.
- C. Architect's Name: CSNA Architects, 532 North Tejon Street, Colorado Springs, CO 80903.

**1.02 CONTRACT DESCRIPTION**

- A. Contract Type: A single prime contract between Owner and Contractor.

**1.03 SCHEDULE OF DRAWINGS, SPECIFICATIONS, AND ADDENDA**

- A. Set of drawings and project manual dated September 23, 2016. Drawing list is as follows.

Sheet No.	Titled
	Cover Sheet
CA2.00-2	CODE ANALYSIS FLOOR PLAN
A0.01-2	INFORMATION SHEET
A0.02-2	PARTITION TYPES
AD1.00-2	DEMOLITION SITE PLAN
AD1.03-2	DEMOLITION SITE PLAN - SW
AD1.04-2	DEMOLITION SITE PLAN - SE
AD2.00-2	DEMOLITION FLOOR PLAN
AD2.03-2	DEMOLITION FLOOR PLAN - SW
AD2.04-2	DEMOLITION FLOOR PLAN - SE
AD2.05-2	DEMOLITION PLANS – ROOF PENTHOUSE
A1.00-2	ARCHITECTURAL SITE PLAN
A1.03-2	ARCHITECTURAL SITE PLAN - SW
A1.04-2	ARCHITECTURAL SITE PLAN - SE
A1.10-2	SITE DETAILS
A1.11-2	SITE ENLARGED PLANS
A2.00-2	FIRST FLOOR PLAN
A2.03-2	FIRST FLOOR PLAN - SW
A2.04-2	FIRST FLOOR PLAN – SE
A2.14-2	REFLECTED CEILING PLAN – SE
A2.23-2	ROOF PLAN – SW
A2.24-2	ROOF PLAN – SE
A3.01-2	EXTERIOR ELEVATIONS
A4.01-2	WALL SECTIONS
A6.00-2	DOOR SCHEDULE & WINDOW TYPES
A6.01-2	WINDOW DETAILS

A6.02-2	DOOR / WINDOW DETAILS
A7.00-2	FINISH SCHEDULE / RCP'S
A7.01-2	TOILET CORES ENLARGED PLANS
A7.02-2	ENLARGED PLANS
S1.00-2	STRUCTURAL DETAILS
M0.01-2	MECHANICAL LEGEND
MD2.01-2	DEMOLITION FIRST FLOOR PLAN SW
MD2.02-2	DEMOLITION FIRST FLOOR PLAN SE
MD2.03-2	DEMOLITION PENTHOUSE PLAN
MD2.04-2	DEMOLITION ROOF PLAN SW
MD2.05-2	DEMOLITION ROOF PLAN SE
MS0.01-2	MECHANICAL SITE PLAN
MH2.01-2	HVAC FIRST FLOOR PLAN - SW
MH2.02-2	HVAC FIRST FLOOR PLAN - SE
MH2.03-2	MECHANICAL PENTHOUSE PLAN
MH2.04-2	MECHANICAL ROOF PLAN – SW
MH2.05-2	MECHANICAL ROOF PLAN – SE
MP2.01-2	MECHANICAL PIPING FIRST FLOOR PLAN - SW
MP2.02-2	MECHANICAL PIPING FIRST FLOOR PLAN - SE
MP2.03-2	MECHANICAL PIPING PENTHOUSE PLAN
M3.01-2	MECHANICAL SECTIONS
M3.02-2	MECHANICAL SECTIONS
M5.01-2	MECHANICAL DETAILS
M5.02-2	MECHANICAL DETAILS
M5.03-2	MECHANICAL DETAILS
M5.04-2	MECHANICAL DETAILS
M6.01-2	MECHANICAL DIAGRAMS
M6.02-2	MECHANICAL DIAGRAMS
M7.01-2	MECHANICAL SCHEDULES
M7.02-2	MECHANICAL SCHEDULES
M7.03-2	MECHANICAL SCHEDULES
MI0.01-2	MECHANICAL INSTRUMENTATION LEGEND
MI6.01-2	MECHANICAL DIAGRAMS (CONTROLS)
MI6.02-2	MECHANICAL DIAGRAMS (CONTROLS)
MI6.03-2	MECHANICAL DIAGRAMS (CONTROLS)
MI6.04-2	MECHANICAL SEQUENCES OF OPERATION
P0.01-2	PLUMBING LEGEND
PD2.01-2	PLUMBING DEMOLITION FIRST FLOOR PLAN - SW
PD2.02-2	PLUMBING DEMOLITION FIRST FLOOR PLAN - SE
PD2.03-2	PLUMBING DEMOLITION PENTHOUSE PLAN
PS1.01-2	PLUMBING SITE PLAN
PL2.01-2	WASTE & VENT FIRST FLOOR PLAN - SW

PL2.02-2	WASTE & VENT FIRST FLOOR PLAN - SE
PL2.03-2	WASTE & VENT PENTHOUSE PLAN
PP2.01-2	PRESSURE PIPING FIRST FLOOR PLAN - SW
PP2.02-2	PRESSURE PIPING FIRST FLOOR PLAN - SE
PP2.03-2	PRESSURE PIPING PENTHOUSE PLAN
P5.01-2	PLUMBING DETAILS
P6.01-2	PLUMBING DIAGRAMS
P7.01-2	PLUMBING SPECIFICATIONS
P7.02-2	PLUMBING SCHEDULES
E0.01-2	ELECTRICAL LEGEND
ES1.01-2	ELECTRICAL SITE PLAN
ED2.01-2	ELECTRICAL DEMOLITION FIRST FLOOR PLAN - SW
ED2.02-2	ELECTRICAL DEMOLITION FIRST FLOOR PLAN - SE
ED2.03-2	ELECTRICAL DEMOLITION PENTHOUSE PLAN
EL2.01-2	LIGHTING FIRST FLOOR PLAN - SW
EL2.02-2	LIGHTING FIRST FLOOR PLAN - SE
EL2.03-2	LIGHTING PENTHOUSE PLAN
EP2.01-2	POWER FIRST FLOOR PLAN - SW
EP2.02-2	POWER FIRST FLOOR PLAN - SE
EP2.03-2	POWER PENTHOUSE PLAN
EG2.01-2	GROUNDING FIRST FLOOR PLAN
EG2.02-2	LIGHTNING PROTECTION ROOF PLAN
E5.01-2	ELECTRICAL DETAIL SHEET
E6.01-2	ELECTRICAL DIAGRAM
E6.02-2	ELECTRICAL DIAGRAM
E6.03-2	GROUNDING DIAGRAM
E7.01-2	ELECTRICAL SECHEDULES
E7.02-2	ELECTRICAL PANEL SECHEDULES
FX0.01-2	FIRE PROTECTION LEGEND
FX2.01-2	FIRE PROTECTION FIRST FLOOR PLAN - SW
FX2.02-2	FIRE PROTECTION FIRST FLOOR PLAN - SE
FX2.03-2	FIRE PROTECTION PENTHOUSE PLAN

- B. Project Manual: University of Colorado - Colorado Springs, National Cybersecurity Center - Core & Shell.
- C. Addenda: All Addenda issued prior to bidding.

#### 1.04 SYSTEM DESCRIPTION

- A. Project Requirements:
  - 1) The intent of this Section is to generally summarize the nature and extent of Work to be performed without in any way limiting the specific requirements of the Contract Documents.
- B. Work Covered by Contract Documents:
  - 1) The Contractor shall provide all labor, equipment, service, facilities, and appurtenances which are indicated by the Drawings, or as specified, or that are required for the Work described in the Contract Documents.

- C. Project Location:
  - UCCS - North Nevada Tenant Building Renovation - Core & Shell
  - 3650 North Nevada Avenue
  - Colorado Springs, Colorado 80907
- D. Project Description:
  - 1) Work will be contained to the south building, not including the connecting corridors. Replacement of existing storefront vestibule entries and exterior windows. Enhance exterior walls to comply with the latest energy code. Two new toilet rooms. New heating and cooling equipment. New electric switch gear. Basic plumbing improvements including new toilet room fixtures.

#### **1.05 EXAMINATION OF SITE**

- A. Failure to Visit Site: Will not relieve Contractor from necessity of furnishing materials or performing work that may be required to complete work in accordance with drawings and specifications without additional cost to Owner.

#### **1.06 OWNER OCCUPANCY**

- A. UCCS intends to continue to occupy adjacent portions of the existing building during the construction period.
- B. Cooperate with UCCS to minimize conflict and to facilitate UCCS's operations.
- C. Schedule the Work to accommodate UCCS occupancy.
- D. See Section 02 41 00, Demolition for coordination of demolition work in existing occupied areas.

#### **1.07 CONTRACTOR USE OF SITE**

- A. Construction Operations: Limited to areas noted on Drawings.
- B. Provide access to and from site as required by law and by UCCS:
  - 1) Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
  - 2) Do not obstruct roadways, sidewalks, or other public ways without permit.
  - 3) Construction Parking: As noted on Contract Drawings or coordinated with the Owner.
- C. Existing building spaces may not be used for storage.

#### **1.08 SPECIFICATION FORMATS AND CONVENTIONS**

- A. Specification Format: The Specifications are organized into Divisions and Sections using the CSI "MasterFormat 2004" version numbering system.
  - 1) Division 1: Sections in Division 1 govern the execution of the Work of all Sections in the Specifications.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1) Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
  - 2) Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may



be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

C. Imperative language is directed to the Contractor.

- 1) The term "provide" used in the text is defined to mean "furnish and install complete, in place, and ready for operation and use", unless specifically indicated otherwise.
- 2) The term "furnish" used in the text is defined to mean "supply and deliver", unless specifically indicated otherwise.
- 3) The term "install" used in the text is defined to mean "place and fix in position, complete and ready for operation and use", unless specifically indicated otherwise

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION - NOT USED**

**END OF SECTION**



## SECTION 01 21 00 ALLOWANCES

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Types of allowances include the following:
  - 1) Lump-sum allowances.
- B. Payment and modification procedures relating to allowances.
  - 1) Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

#### 1.02 LUMP-SUM ALLOWANCES

- A. Requirements in this article coordinate with AIA Document A201. Revise to suit Project. For individual allowance items that include installation labor or other costs, provide detailed description of covered costs in "Schedule of Allowances" Article.
- B. Allowance shall include cost to Contractor of specific products and materials under allowance and shall include taxes, freight, and delivery to Project site.
- C. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials under allowance shall be included as part of the Contract Sum and not part of the allowance.
- D. Retain "Unused Materials" Paragraph below if allowances are not used for low-cost or single-unit items only.
- E. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.

#### 1.03 ADJUSTMENT OF ALLOWANCES

- A. Retain this article if allowances are not used for low-cost or single-unit items. Specify requirements for extra materials (attic stock) in the Section that specifies the product covered by the allowance.
- B. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order Proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
  - 1) Include installation costs in purchase amount only where indicated as part of the allowance.
  - 2) If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
  - 3) Delete both subparagraphs below if no unit-cost allowances.
  - 4) Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
  - 5) Subparagraph below reflects the major problem of unit-cost allowances. No matter who performs the Work, a final quantity survey is needed.
  - 6) Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

#### **1.04 INFORMATIONAL SUBMITTALS**

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

#### **1.05 ALLOWANCES SCHEDULE**

- A. Include the stipulated sum of \$ 30,000 for purchase, delivery, and installation of new mechanical yard metal wall.
- B. Include the stipulated sum of \$ 100,000 for purchase, delivery, and installation of new landscaping and reworking of existing irrigation system.
- C. Include the stipulated sum of \$ 2,500 for purchase, delivery, and installation of new site signage.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION - NOT USED**

**END OF SECTION**

## **SECTION 01 22 00 UNIT PRICES**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. List of unit prices, for use in preparing Bids.
- B. Measurement and payment criteria applicable to Work performed under a unit price payment method.

#### **1.02 RELATED REQUIREMENTS**

- A. Division 0 - Bidding and Contract Requirements.

#### **1.03 COSTS INCLUDED**

- A. Unit Prices included on the Bid Form shall include full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

#### **1.04 UNIT QUANTITIES SPECIFIED**

- A. Quantities indicated in the Bid Form are for bidding and contract purposes only. Quantities and measurements of actual Work will determine the payment amount.

#### **1.05 MEASUREMENT OF QUANTITIES**

- A. Measurement methods delineated in the individual specification sections complement the criteria of this section. In the event of conflict, the requirements of the individual specification section govern.
- B. Assist by providing necessary equipment, workers, and survey personnel as required.

#### **1.06 PAYMENT**

- A. Payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities of Work that is incorporated in or made necessary by the Work and accepted by the Architect, multiplied by the unit price.
- B. Payment will not be made for any of the following:
  - 1) Products wasted or disposed of in a manner that is not acceptable.
  - 2) Products determined as unacceptable before or after placement.
  - 3) Products not completely unloaded from the transporting vehicle.
  - 4) Products placed beyond the lines and levels of the required Work.
  - 5) Products remaining on hand after completion of the Work.
  - 6) Loading, hauling, and disposing of rejected Products.

#### **1.07 SCHEDULE OF UNIT PRICES**

- A. Item1: Add concrete subfloor sealer on floors specified in Section 09 30 00, Tiling. Unit price per square foot to add the sealer on concrete subfloor if test results determine a sealer is required to meet the moisture/alkalinity emission rate specified.; Section 09 05 61, Common Work Results for Flooring Preparation.
- B. Item 2: Add concrete subfloor sealer on floors specified in Section 09 65 00, Resilient Flooring. Unit price per sq. ft. to add sealer on concrete subfloor if test results determine a sealer is required to meet the moisture/alkalinity emission rate specified.; Section 09 05 61, Common Work Results for Flooring Preparation.

### **PART 2 PRODUCTS - NOT USED**

### **PART 3 EXECUTION - NOT USED**

## **END OF SECTION**



**SECTION 01 23 00**  
**ALTERNATES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Description of Alternates.
- B. Procedures for pricing Alternates.

**1.02 RELATED REQUIREMENTS**

- A. Bidding and Contract Requirements.

**1.03 ACCEPTANCE OF ALTERNATES**

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at UCCS's option. Accepted Alternates will be identified in the Owner-Contractor Agreement.
- B. Refer to the Drawings and Specifications for additional information regarding each Alternate. Where Drawings and/or Specifications are inconsistent, and the inconsistency was not corrected by Addendum, the bid shall be calculated for the greater quantity and superior quality of work.
- C. The Contractor shall submit proposals for all alternates. Alternate proposals shall be those costs which may be added to or deducted from the base bid should the described work be added to or deleted from the contract for construction. The Base Bid shall reflect all work including described deductive alternates and excluding described additive alternates. Failure to submit proposals for all alternates may result in rejection of bid.
- D. Proposals for Alternate work shall reflect the difference in price for all trades impacted by all additions, deletions, substitutions, changes, or modifications, and shall include all incidental items necessary but not specifically identified.
- E. Coordinate related work and modify surrounding work to integrate the Work of each Alternate.

**1.04 SCHEDULE OF ALTERNATES**

- A. Alternate No. 01 – Removal of select walls west of grid line ES.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION - NOT USED**

**END OF SECTION**





**SECTION 01 30 00**  
**ADMINISTRATIVE REQUIREMENTS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Preconstruction meeting.
- B. Progress meetings.
- C. Construction progress schedule.
- D. Submittals for review, information, and project closeout.
- E. Submittal procedures.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 33 00 - Submittal Procedures.
- B. Section 01 78 00 - Closeout Submittals: Project record documents.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION**

**3.01 PRECONSTRUCTION MEETING**

- A. UCCS will schedule a meeting after Notice of Award.
- B. Attendance Required:
  - 1) UCCS.
  - 2) Architect.
  - 3) Contractor.
- C. Agenda:
  - 1) Execution of UCCS- Contractor Agreement.
  - 2) Submission of executed bonds and insurance certificates.
  - 3) Distribution of Contract Documents.
  - 4) Submission of list of Subcontractors, schedule of values, and progress schedule.
  - 5) Designation of personnel representing the parties to Contract , Owner and Architect.
  - 6) Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
  - 7) Scheduling.
- D. Record minutes and distribute copies within two days after meeting to participants, with electronic copies to Architect, UCCS, participants, and those affected by decisions made.

**3.02 PROGRESS MEETINGS**

- A. Schedule and administer meetings throughout progress of the Work at weekly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- C. Attendance Required:
  - 1) Contractor.
  - 2) UCCS.
  - 3) Architect.
  - 4) Contractor's Superintendent.
- D. Agenda:

- 1) Review minutes of previous meetings.
  - 2) Review of Work progress.
  - 3) Field observations, problems, and decisions.
  - 4) Identification of problems that impede, or will impede, planned progress.
  - 5) Review of RFI's.
  - 6) Review Change Order Requests.
  - 7) Review of submittals schedule and status of submittals.
  - 8) Other business relating to Work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, UCCS, participants, and those affected by decisions made.

### **3.03 CONSTRUCTION PROGRESS SCHEDULE**

- A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.
- B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
  - 1) Include written certification that major contractors have reviewed and accepted proposed schedule.
- D. Within 10 days after joint review, submit complete schedule.
- E. Submit updated schedule with each Application for Payment.

### **3.04 SUBMITTALS FOR REVIEW**

- A. See Section 01 33 00, "Submittal Procedures".

### **3.05 SUBMITTALS FOR PROJECT CLOSEOUT**

- A. See Section 01 78 00, Closeout Submittals.
- B. Submit Correction Punch List for Substantial Completion.
- C. Submit for UCCS's benefit during and after project completion.

## **END OF SECTION**

## **SECTION 01 33 00**

### **SUBMITTAL PROCEDURES**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 21 00 - Cash, testing, and contingency allowances.
- B. Section 01 22 00 - Descriptions of unit price items, administrative requirements.
- C. Section 01 23 00 - Descriptions of items, administrative requirements.
- D. Section 01 30 00 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.
- E. Section 01 41 00 - Regulatory Requirements.
- F. Section 01 42 19 - Reference Standards: Consolidated list of citations with edition dates.
- G. Section 01 50 00.
- H. Section 01 60 00 - Fundamental product requirements, substitutions and product options, delivery, storage, and handling.
- I. Section 01 70 00 - Examination, preparation, and general installation procedures; preinstallation meetings; cutting and patching; cleaning and protection; starting of systems; demonstration and instruction; closeout procedures except payment procedures; requirements for alterations work.
- J. Section 01 78 00 - Closeout Submittals: Project record documents, operation and maintenance (O&M) data, warranties and bonds.
- K. Section 01 79 00 - Demonstration and Training: Detailed requirements.

##### **1.03 DEFINITIONS**

- A. Action Submittals: Written and graphic information that requires Architect's responsive action.
- B. Informational Submittals: Written information that does not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

##### **1.04 SUBMITTAL ADMINISTRATIVE REQUIREMENTS**

- A. The General Contractor does not have permission from CSNA Architects to allow subcontractors to use CSNA's BIM Model for the use of submittal background drawings.
- B. Architect's Building Information Model: Electronic copies converted to AutoCAD of the project model will be provided by CSNA for each individual sub-contractor use in preparing submittals for a fee of \$500.00 for each instance of use/distribution.
  - 1) Architect makes no representations as to the accuracy or completeness of the AutoCAD drawings as it relates to the Contract Drawings.
  - 2) The AutoCAD drawings will be made available in AutoCAD Arch 2015.
  - 3) Contractor shall execute CSNA's, "Agreement For Use of AutoCAD Files", prior to transfer of any drawing files.

## **PART 2 PRODUCTS**

### **2.01 SUBMITTAL LIST**

- A. The Contractor shall prepare a schedule of anticipated submittal dates which shall include the date of delivery to the Architect and the date the submittal is to be returned to the Contractor. No adjustments for project delays due to rejection of submittals will be considered. This schedule shall be submitted to the Architect within fifteen (15) days after Award of Contract.
- B. Revise and update each projects schedule on a monthly basis as necessary to reflect conditions and sequences. Promptly submit any revised schedules to the Architect for review.

### **2.02 SUBMITTAL SCHEDULE**

- A. Compile complete schedule of all submittals anticipated to be made during progress of work. Include list of each type of item for which Contractor's drawings, shop drawings, product data, Certificates of Compliance, samples, warranties, or other types of submittals are required.
- B. On acceptance by Architect, Contractor shall adhere to schedule except when specifically otherwise permitted.
- C. Coordinate and sequence submittals to avoid delays in the work. Submittals re-quiring review or selection by the Architect will be acted upon with reasonable promptness. Contractor shall provide a number sequence for submittals to identify submittals and relate them to subsequent submittals.
- D. Under no circumstances shall unreviewed submittals be permitted to be used in conjunction with the work. Work executed without required review and approval by the Architect shall be subject to rejections. Removal and reconstruction of this rejected work shall be at the Contractor's expense.

### **2.03 CODE DESIGNATION**

- A. On schedule, designate each item with number code utilizing specification section six digit numbers.
  - 1) Each submittal shall be marked with same code designation for easy tracking.

### **2.04 SUBMITTALS**

- A. Contractor: Submittals are to be made as electronic submittals unless otherwise noted below.
  - 1) Electronic Submittals:
    - a. Post electronic submittals using one of the following: PDF electronic files directly to a Project Web Site, Architects FTP site, directly to Architect, or Contractor's project software.
    - b. Architect will review and return annotated file.
  - 2) Identify each submittal with the following information noted for each submittal and noted on the submittal transmittal form:
    - a. Name of the project
    - b. Name, address and telephone number of Trade Contractor, supplier, manufacture and any other second tier contractor associated with the submittal
    - c. Date
    - d. General Contractor
    - e. Submittal name and number
    - f. Specification Section number governing the submittal

- g. If submittal pertains to more than one spec section, identify each section to which the submittal pertains.

## **2.05 COORDINATION**

- A. Coordinate schedule with Trade Contractors and materials suppliers.

## **2.06 SUBMISSION OF SUBMITTALS**

- A. Submission of Shop Drawings, Product Data, and Samples and O&M Manuals shall constitute a representation by the Contractor that he/she has reviewed the submittal and that all measurements, conditions, and relevant criteria of the Construction Documents have been checked, verified, and coordinated. The Contractor shall affix his electronic stamp and signature to the submittal certifying that the items being submitted have been checked for compliance with the contract documents.

## **2.07 SUBMITTAL PROCESS**

- A. Contractor:
  - 1) Review shop drawings for accuracy, completeness, and conformity with Contract Documents. Make notes and corrections on all copies.
  - 2) Stamp with Contractor's electronic stamp/date. Signature of individual who review shop drawings is required below Contractor's stamp.
  - 3) Print as required for Contractor's record.
  - 4) Send electronic file to the Architect.
  - 5) Shop drawings not stamped and signed by Contractor will be returned.
- B. Architect:
  - 1) Send one electronic copy to any consultant for review.
  - 2) Check shop drawing by making notes and corrections on both copies. Add any comments from the consultants review.
  - 3) Electronically stamp and mark "No Exceptions Taken", "Revise and Resubmit", "Rejected", etc., as required.
  - 4) Retain electronic copy with mark-ups and transmit electronic copy back to Contractor.
- C. Contractor:
  - 1) Send copy to trade contractor.
- D. Trade Contractor:
  - 1) Print necessary copies for record, distribution, etc.
- E. Resubmittal: In event shop drawings have to be resubmitted to Architect, the Contractor shall make corrections and re-route new electronic files as outlined above for re-review.
- F. Do not proceed with purchase, fabrication, or installation of submittal related work until marked either "No Exception Taken" or "Make Corrections Noted" by the Architect. Resubmit as required until so marked by the Architect. Work which is executed without required prior review by the Architect shall be subject to rejection. Removal and reconstruction of rejected work shall be at the Contractor's expense.
- G. Submittals marked "Submit Specified Item" are so identified to indicate that the item submitted for review is not a product or material approved for use in the project. Submittal of one of the approved products or materials is required.
- H. Submittals marked "Revise & Resubmit" shall be changed according to notes attached to the submittal and shall be resubmitted.
- I. Submittals marked "Rejected" shall be changed according to notes attached to the submittal and shall be resubmitted.

## **2.08 QUALITY ASSURANCE**

- A. The Architect's review of submittals is for overall design conformance, color, texture, pattern, etc. The Contractor shall assume full responsibility for dimensional accuracy, quantity, compliance with Drawings and Specifications, performance, errors, and omissions of Submittals. Any and all variations between submittals and Contract requirements shall be specifically identified by the Contractor (in writing on the submittal) at the time of submission. Such variations shall be considered nonconforming work unless specifically waived in writing by the Architect. REVIEW BY THE ARCHITECT SHALL NOT RELIEVE THE CONTRACTOR FROM FULL COMPLIANCE WITH REQUIREMENTS OF THE CONSTRUCTION DOCUMENTS.
- B. Submittals processed by the Architect are not Change Orders. The purpose of submittals is to demonstrate to the Architect that the Contractor understands the design concept, and that such understanding is demonstrated by indicating and detailing the fabrication and installation methods intended to be used.
- C. If deviations, discrepancies, or conflicts between Shop Drawing Submittals and the design drawings/specifications are discovered either prior to or after Shop Drawing Submittals are processed by the Architect, the design drawings/specifications shall control and shall be followed unless specifically approved in writing by the Architect.

## **2.09 COLOR SELECTION**

- A. No color, pattern or texture selections will be made until all samples have been received by Architect.

## **2.10 CERTIFICATE OF COMPLIANCE**

- A. Certificates:
  - 1) Where Certificates of Compliance are specified, show on each certification name and location of work, name, and address of Contractor; quantity and date or dates of shipment or delivery to which certificate applies; and name of manufacturer.
  - 2) Certification: In form of letter or company standard forms.
  - 3) Certificates: Signed by officer of manufacturer.
  - 4) Laboratory Test Reports: Show date of testing, specified requirements for which testing was performed, and results of tests.

## **2.11 DELIVERY**

- A. Unless otherwise noted in writing upon submission to the Architect, Submittals shall constitute an implied statement by the Contractor that submitted items can be fabricated and delivered to the project site without delay to the project schedule.

## **2.12 CLOSEOUT**

- A. The Contractor will maintain electronic files. One set of final approved electronic submittal files to be delivered on a CD to the Owner with the Project Closeout Documents, O&M Manuals and Record Drawings.

## **PART 3 EXECUTION**

### **3.01 SHOP DRAWINGS**

- A. Shop Drawings: Shall be clear and accurate graphic representations drawn at an appropriate scale, with complete information, details, and dimensions necessary for proper fabrication, construction, assembly, and installation. Shop Drawings shall convey compliance with the intent of the design and provide relevant information needed by others who may have to interface or coordinate with the construction or installation of the product submitted. Make particular note of field-measured

dimensions, as-built conditions, and conditions requiring special coordination with other contractors and requirements of activities of Owner.

### **3.02 FIELD MEASUREMENTS**

- A. Field Measurements: Responsibility of Contractor.

### **3.03 PRODUCT DATA**

- A. Trade Contractor: Submit electronic files of brochure material for products to be used in the Work and be properly identified. Product samples associated with product data to be used in the Work to be properly identified.
- B. Routing: Routing will be as indicated in the Submittal Process portion of this Section.
- C. Reference: Reference product data to applicable drawings and specification sections to facilitate ease and accuracy of checking.
- D. When contents of submitted literature from manufacturer include data not pertinent to submittal, clearly indicate which portion of contents is being submitted for review.

### **3.04 SAMPLES**

- A. Checklist: Provide samples identical to conditions and materials proposed in the work. Where the Architect's selection is required, provide a complete set of optional samples. Where required, prepare samples to conform to the Architect's specifications.
- B. Submittal: Promptly after receipt of checklist, assemble, and deliver to Architect complete collection of required samples. Unless otherwise specified, submit samples in quantity that is required to be returned plus one which will be retained by Architect.
- C. Along with physical samples, submit electronic file identifying each sample submittal with the following information noted for each sample and noted on the submittal transmittal form. Samples shall bear a physical tag or label providing the following information:
  - 1) Project name and location.
  - 2) Manufacturer, supplier.
  - 3) Name, finish, and composition of material.
  - 4) Location of where material is to be used.
  - 5) Specification section number.
  - 6) Labels: Large enough for acceptance stamp.
- D. Selection: Upon receipt of complete collection of samples, Architect will, with reasonable promptness, make selections and prepare and deliver to Contractor schedule covering items subject to selection. Architect reserves right not to make individual determination or selections until all samples of all materials are submitted.

### **3.05 MANUFACTURER QUALIFICATION/CERTIFICATION**

- A. Submit electronic copies of required manufacturer certifications.

### **3.06 QUALIFICATION/CERTIFICATION**

- A. Applicator/Installer Qualification/Certification:
  - 1) Applicator/Installer qualification documentation shall consist of a certificate, letter, or other appropriate document issued by a product manufacturer or regulatory agency which states that the company or individual who is applying or installing the product has been trained and is currently certified by the certificate issuer and that product guarantees/warranties will be honored.
    - a. Submit electronic copies of each qualification/certification document.
    - b. Failure to submit certification data or failure to satisfy minimum standards shall be grounds for rejection of the candidate contractor or trade contractor under the terms of the General Conditions for Construction.

- c. Work which is executed without required certification shall be subject to rejection and complete replacement at the expense of the Contractor. No contract extension shall be granted for rejection of an unqualified or uncertified contractor.
- B. Trade Qualification:
- 1) Where identified in other portions of the contract documents, Contractors performing certain portions of the work shall provide written certification of experience and/or other unique qualifications.
    - a. Submit to the Architect electronic copies of a written statement summarizing the contractor's ability to meet requirements specified in the relevant specification sections.
    - b. Where a listing of completed projects is required, include associated contact names and telephone numbers.
    - c. Where manufacturer's certifications are required, submit electronic copies of manufacturer's certification to the Architect for review and approval.
  - 2) Do not proceed with related work until submitted Qualifications and/or Certifications have been reviewed and approved by the Architect. Work executed without prior approval of Qualifications and/or Certifications shall be subject to rejection. No time extensions will be permitted due to the rejection of proposed trade contractors because of failure to meet Certification or Qualification requirements.
  - 3) Work executed without approval of required Qualification or Certification submittals will be subject to rejection at the discretion of Architect.

### **3.07 OPERATION AND MAINTENANCE MANUALS**

- A. Submit Operation and Maintenance Manuals per Section 01 78 00, Closeout Submittals.

**END OF SECTION**



## SECTION 01 40 00 QUALITY REQUIREMENTS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. References and standards.
- B. Control of installation.
- C. Tolerances.

#### 1.02 RELATED REQUIREMENTS

- A. Section 01 42 19 - Reference Standards.
- B. Section 01 60 00 - 01 60 00: Requirements for material and product quality.

#### 1.03 REFERENCES AND STANDARDS

- A. Obtain copies of standards where required by product specification sections.
- B. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

#### 1.04 TESTING AND INSPECTION AGENCIES AND SERVICES

- A. As indicated in individual specification sections, UCCS or Contractor shall employ and pay for services of an independent testing agency to perform specified testing and inspection.
- B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
- C. Contractor: Provide equipment and facilities as required, subject to Architect's review, for conducting field tests and for collecting and forwarding samples.
  - 1) Do not use materials or equipment represented by samples until tests, if required, have been made and materials or equipment found to be acceptable.
  - 2) Do not incorporate any product into work which becomes unfit for use after acceptance thereof.
- D. Testing: Materials or equipment proposed to be used may be tested at any time during their preparation or use. Furnish required samples without charge and give sufficient notice of placing of orders to permit testing. Products may be sampled either prior to shipment or after being received at site of work.
- E. Contractor Employed Agency:
  - 1) Testing agency: Comply with requirements of ASTM E329, ASTM E543, ASTM C1021, ASTM C1077, ASTM C1093, ASTM D3740.
  - 2) Inspection agency: Comply with requirements of ASTM D3740, ASTM E329.
  - 3) Laboratory Qualifications: Accredited by IAS according to IAS AC89.
  - 4) Laboratory: Authorized to operate in the State in which the Project is located.
  - 5) Laboratory Staff: Maintain a full time registered Engineer on staff to review services.
  - 6) Testing Equipment: Calibrated at reasonable intervals either by NIST or using an NIST established Measurement Assurance Program, under a laboratory measurement quality assurance program.

## **PART 2 PRODUCTS (NOT USED)**

## **PART 3 EXECUTION**

### **3.01 TEST REPORTS**

- A. Reports of tests made by testing laboratories shall be distributed by testing laboratory as follows:
  - 1) 1 Copy - Contractor
  - 2) 1 Copy - Owner
  - 3) 1 Copy - Architect

### **3.02 CONTROL OF INSTALLATION**

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Quality Control Plan: Submit with proposed Construction Progress Schedule. Plan shall include:
  - 1) Personnel, procedures, instructions, and records to be used.
  - 2) List of control tests which Contractor understands he and his subcontractors are to perform.
  - 3) Procedures for reviewing and approving shop drawings, product data, samples and other submittals before submission to Architect. Include procedures for obtaining field measurements.
  - 4) Method of documenting quality control operation, inspection and testing including samples of proposed forms.
- D. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- E. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- F. Have Work performed by persons qualified to produce required and specified quality.
- G. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- H. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.
- I. Records: Maintain correct records on appropriate forms for all inspections and tests performed, instructions received from Architect and actions taken as result of those instructions.
  - 1) Records: Include evidence that required inspections or tests have been performed (including type and number of inspections or tests, nature of defects, causes for rejection, etc.) proposed or directed remedial action, and corrective action taken.
  - 2) Document inspections and tests as required by each section of specifications.
- J. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

### **3.03 TOLERANCES**

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

- B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

### **3.04 TESTING AND INSPECTION**

- A. See individual specification sections for testing and inspection required.
- B. Testing Agency Duties:
  - 1) Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
  - 2) Perform specified sampling and testing of products in accordance with specified standards.
  - 3) Ascertain compliance of materials and mixes with requirements of Contract Documents.
  - 4) Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
  - 5) Perform additional tests and inspections required by Architect.
  - 6) Submit reports of all tests/inspections specified.
- C. Limits on Testing/Inspection Agency Authority:
  - 1) Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
  - 2) Agency may not approve or accept any portion of the Work.
  - 3) Agency may not assume any duties of Contractor.
  - 4) Agency has no authority to stop the Work.
- D. Contractor Responsibilities:
  - 1) Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
  - 2) Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
  - 3) Provide incidental labor and facilities:
    - a. To provide access to Work to be tested/inspected.
    - b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
    - c. To facilitate tests/inspections.
    - d. To provide storage and curing of test samples.
  - 4) Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
  - 5) Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
  - 6) Arrange with UCCS's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- E. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.
- F. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

### **3.05 MANUFACTURERS' FIELD SERVICES**

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions,

conditions of surfaces and installation, quality of workmanship, as applicable, and to initiate instructions when necessary.

- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

### **3.06 DEFECT ASSESSMENT**

- A. Replace Work or portions of the Work not conforming to specified requirements.

**END OF SECTION**

**SECTION 01 41 00**  
**REGULATORY REQUIREMENTS**

**PART 1 GENERAL**

**1.01 SUMMARY OF REFERENCE STANDARDS**

- A. Regulatory requirements applicable to this project are the following:
- B. 29 CFR 1910 - Occupational Safety and Health Standards; current edition.
- C. State of Colorado amendments to some or all of the following.
- D. ICC (IFC) - International Fire Code; 2015.
- E. ICC (IEBC) - ICC International Existing Building Code, 2015.
- E. ICC (IBC) - ICC International Building Code, 2015.
- F. ICC (IPC) - International Plumbing Code; 2015.
- G. ICC (IMC) - International Mechanical Code; 2015.
- H. ICC (IFGC) - International Fuel Gas Code; 2015.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. ICC (IECC) - International Energy Conservation Code; 2015.
- K. 2011 Pikes Peak Regional Building Code.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 40 00 - Quality Requirements.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION - NOT USED**

**END OF SECTION**



## SECTION 01 42 19 REFERENCE STANDARDS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Requirements relating to referenced standards.
- B. Reference standards full title and edition date.

#### 1.02 QUALITY ASSURANCE

- A. For products or workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard of date of issue current on date for receiving bids, except where a specific date is established by applicable code.
- C. Should specified reference standards conflict with Contract Documents, request clarification from the Architect before proceeding.
- D. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of the Architect shall be altered by the Contract Documents by mention or inference otherwise in any reference document.
- E. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

#### 1.03 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.

- I. "Project Site": Space available for performing construction activities. The extent of Project Site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.



1.04

**PART 2 CONSTRUCTION INDUSTRY ORGANIZATION DOCUMENTS**

- 2.01 AA -- ALUMINUM ASSOCIATION, INC.
- 2.02 AABC -- ASSOCIATED AIR BALANCE COUNCIL
- 2.03 AAMA -- AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION
- 2.04 AASHTO -- AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
- 2.05 AATCC -- AMERICAN ASSOCIATION OF TEXTILE CHEMISTS & COLORISTS
- 2.06 ABMA -- AMERICAN BEARING MANUFACTURERS ASSOCIATION, INC.
- 2.07 ACA -- AMERICAN COATINGS ASSOCIATION
- 2.08 ACI -- AMERICAN CONCRETE INSTITUTE INTERNATIONAL
- 2.09 ADC -- AIR DIFFUSION COUNCIL
- 2.10 AFPA -- AMERICAN FOREST AND PAPER ASSOCIATION
- 2.11 AGA -- AMERICAN GALVANIZERS ASSOCIATION, INC.
- 2.12 AGC -- ASSOCIATED GENERAL CONTRACTORS OF AMERICA
- 2.13 AHA -- AMERICAN HARDBOARD ASSOCIATION
- 2.14 AHAM -- ASSOCIATION OF HOME APPLIANCE MANUFACTURERS:
- 2.15 AHRI -- AIR-CONDITIONING, HEATING, AND REFRIGERATION INSTITUTE
- 2.16 AI -- THE ASPHALT INSTITUTE
- 2.17 AIA -- THE AMERICAN INSTITUTE OF ARCHITECTS
- 2.18 AISC -- AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC.
- 2.19 AISI -- AMERICAN IRON AND STEEL INSTITUTE
- 2.20 AITC -- AMERICAN INSTITUTE OF TIMBER CONSTRUCTION
- 2.21 ALSC -- AMERICAN LUMBER STANDARDS COMMITTEE
- 2.22 AMCA -- AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.
- 2.23 ANSI -- AMERICAN NATIONAL STANDARDS INSTITUTE
- 2.24 AOSA -- ASSOCIATION OF OFFICIAL SEED ANALYSTS
- 2.25 APA -- APA - THE ENGINEERED WOOD ASSOCIATION
- 2.26 APHA -- AMERICAN PUBLIC HEALTH ASSOCIATION
- 2.27 API -- AMERICAN PETROLEUM INSTITUTE
- 2.28 API -- ALLIANCE FOR THE POLYURETHANES INDUSTRY, AMERICAN PLASTICS COUNCIL
- 2.29 ARI -- AIR-CONDITIONING AND REFRIGERATION INSTITUTE (SEE AHRI)
- 2.30 ASA -- ACOUSTICAL SOCIETY OF AMERICA
- 2.31 ASCA -- ARCHITECTURAL SPRAY COATERS ASSOCIATION
- 2.32 ASCE -- AMERICAN SOCIETY OF CIVIL ENGINEERS
- 2.33 ASHRAE -- AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
- 2.34 ASME -- THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
- 2.35 ASSE -- AMERICAN SOCIETY OF SANITARY ENGINEERING
- 2.36 ASTM A SERIES -- ASTM INTERNATIONAL
- 2.37 ASTM B SERIES -- ASTM INTERNATIONAL

- 2.38 ASTM C SERIES -- ASTM INTERNATIONAL
- 2.39 ASTM D SERIES -- ASTM INTERNATIONAL
- 2.40 ASTM E SERIES -- ASTM INTERNATIONAL
- 2.41 ASTM F SERIES -- ASTM INTERNATIONAL
- 2.42 ASTM G SERIES -- ASTM INTERNATIONAL
- 2.43 AWCI -- ASSOCIATION OF THE WALL AND CEILING INDUSTRIES INTERNATIONAL
- 2.44 AWI -- ARCHITECTURAL WOODWORK INSTITUTE
- 2.45 AWWA -- AMERICAN WOOD-PRESERVERS' ASSOCIATION
- 2.46 AWS -- AMERICAN WELDING SOCIETY
- 2.47 AWWA -- AMERICAN WATER WORKS ASSOCIATION
- 2.48 BHMA -- BUILDERS HARDWARE MANUFACTURERS ASSOCIATION
- 2.49 BIA -- BRICK INDUSTRY ASSOCIATION
- 2.50 BIFMA -- BUSINESS AND INSTITUTIONAL FURNITURE MANUFACTURERS ASSOCIATION
- 2.51 BOCA -- BUILDING OFFICIALS & CODE ADMINISTRATORS INTERNATIONAL, INC.
- 2.52 C2C -- CRADLE TO CRADLE PRODUCTS INNOVATION INSTITUTE
- 2.53 CABO -- COUNCIL OF AMERICAN BUILDING OFFICIALS:
- 2.54 CDA -- COPPER DEVELOPMENT ASSOCIATION, INC.
- 2.55 CGA -- COMPRESSED GAS ASSOCIATION
- 2.56 CGSB -- CANADIAN GENERAL STANDARDS BOARD
- 2.57 CISCA -- CEILINGS & INTERIOR SYSTEMS CONSTRUCTION ASSOCIATION
- 2.58 CISPI -- CAST IRON SOIL PIPE INSTITUTE
- 2.59 CLFMI -- CHAIN LINK FENCE MANUFACTURERS INSTITUTE
- 2.60 CPA -- COMPOSITE PANEL ASSOCIATION
- 2.61 CPSC -- CONSUMER PRODUCTS SAFETY COMMISSION
- 2.62 CRI -- CARPET AND RUG INSTITUTE
- 2.63 CRRC -- COOL ROOF RATING COUNCIL
- 2.64 CRSI -- CONCRETE REINFORCING STEEL INSTITUTE
- 2.65 CSI/CSC -- CONSTRUCTION SPECIFICATIONS INSTITUTE/CONSTRUCTION SPECIFICATIONS CANADA
- 2.66 CTI -- CERAMIC TILE INSTITUTE
- 2.67 CTI -- COOLING TECHNOLOGY INSTITUTE
- 2.68 DASMA -- DOOR & ACCESS SYSTEMS MANUFACTURERS' ASSOCIATION, INTERNATIONAL
- 2.69 DBIA -- THE DESIGN BUILD INSTITUTE OF AMERICA, INC.
- 2.70 DHI -- DOOR AND HARDWARE INSTITUTE
- 2.71 EIA -- ELECTRONIC INDUSTRIES ALLIANCE
- 2.72 EIMA -- EXTERIOR INSULATION MANUFACTURERS ASSOCIATION
- 2.73 EJCDC -- ENGINEERS' JOINT CONTRACT DOCUMENTS COMMITTEE
- 2.74 EJMA -- EXPANSION JOINT MANUFACTURERS ASSOCIATION
- 2.75 FM -- FACTORY MUTUAL GLOBAL
- 2.76 GA -- GYPSUM ASSOCIATION

- 2.77 GANA -- GLASS ASSOCIATION OF NORTH AMERICA
- 2.78 GEI -- GREENGUARD ENVIRONMENTAL INSTITUTE
- 2.79 GREENSEAL -- GREEN SEAL, INC.
- 2.80 GRI -- GEOSYNTHETIC RESEARCH INSTITUTE
- 2.81 HPVA -- HARDWOOD PLYWOOD VENEER ASSOCIATION
- 2.82 HPW -- H.P. WHITE LABORATORY, INC.
- 2.83 IAPMO -- INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS
- 2.84 IAS -- INTERNATIONAL ACCREDITATION SERVICE
- 2.85 ICBO -- INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS
- 2.86 ICC -- INTERNATIONAL CODE COUNCIL, INC.
- 2.87 ICC-ES -- ICC EVALUATION SERVICE, INC.
- 2.88 ICEA -- INSULATED CABLE ENGINEERS ASSOCIATION
- 2.89 IEC -- INTERNATIONAL ELECTROTECHNICAL COMMISSION
- 2.90 IEEE -- INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS
- 2.91 IES/IESNA -- ILLUMINATING ENGINEERING SOCIETY
- 2.92 IGMA -- INSULATING GLASS MANUFACTURERS ALLIANCE
- 2.93 ILI -- INDIANA LIMESTONE INSTITUTE OF AMERICA, INC.
- 2.94 IMIAWC -- INTERNATIONAL MASONRY INDUSTRY ALL-WEATHER COUNCIL
- 2.95 ISA -- INSTRUMENT SOCIETY OF AMERICA
- 2.96 ISDI -- INSULATED STEEL DOOR INSTITUTE
- 2.97 ISFA - INTERNATIONAL SURFACE FABRICATORS ASSOCIATION
- 2.98 ISS -- IRON AND STEEL SOCIETY
- 2.99 ISSFA - INTERNATIONAL SOLID SURFACE FABRICATORS ASSOCIATION
- 2.100 ISO -- INTERNATIONAL STANDARDS ORGANIZATION
- 2.101 ITS -- INTERTEK TESTING SERVICES NA, INC.
- 2.102 KCMA -- KITCHEN CABINET MANUFACTURERS ASSOCIATION
- 2.103 LIA -- LEAD INDUSTRIES ASSOCIATION, INC.
- 2.104 LPI -- LIGHTNING PROTECTION INSTITUTE
- 2.105 MBMA -- METAL BUILDING MANUFACTURERS ASSOCIATION
- 2.106 MFMA -- MAPLE FLOORING MANUFACTURERS ASSOCIATION
- 2.107 MFMA -- METAL FRAMING MANUFACTURERS ASSOCIATION
- 2.108 MIA -- MARBLE INSTITUTE OF AMERICA, INC.
- 2.109 ML/SFA -- METAL LATH/STEEL FRAMING ASSOCIATION - SEE NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS
- 2.110 MPI -- MASTER PAINTERS INSTITUTE (MASTER PAINTERS AND DECORATORS ASSOCIATION)
- 2.111 MMSA -- MATERIALS AND METHODS STANDARDS ASSOCIATION
- 2.112 MSS -- MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, INC.
- 2.113 NAAMM -- THE NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS
- 2.114 NACE -- NACE INTERNATIONAL

2.115 NADCA -- NATIONAL AIR DUCT CLEANING ASSOCIATION  
2.116 NAMM -- NATIONAL ASSOCIATION OF MIRROR MANUFACTURERS  
2.117 NBGQA -- NATIONAL BUILDING GRANITE QUARRIES ASSOCIATION, INC.  
2.118 NCAA -- NATIONAL COLLEGIATE ATHLETIC ASSOCIATION:  
2.119 NCMA -- NATIONAL CONCRETE MASONRY ASSOCIATION  
2.120 NCWPB - NATIONAL CERTIFIED PIPE WELDING BUREAU  
2.121 NEBB -- NATIONAL ENVIRONMENTAL BALANCING BUREAU  
2.122 NECA -- NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION  
2.123 NEII -- NATIONAL ELEVATOR INDUSTRY, INC.  
2.124 NELMA -- NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION, INC.  
2.125 NEMA -- NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION  
2.126 NETA -- INTERNATIONAL ELECTRICAL TESTING ASSOCIATION  
2.127 NFPA -- NATIONAL FIRE PROTECTION ASSOCIATION  
2.128 NFRC -- NATIONAL FENESTRATION RATING COUNCIL, INC.  
2.129 NFSMI -- NATIONAL FOOD SERVICE MANAGEMENT INSTITUTE:  
2.130 NHLA -- NATIONAL HARDWOOD LUMBER ASSOCIATION  
2.131 NLA -- NATIONAL LIME ASSOCIATION  
2.132 NOFMA -- NATIONAL OAK FLOORING MANUFACTURERS ASSOCIATION  
2.133 NPA -- NATIONAL PARTICLEBOARD ASSOCIATION  
2.134 NPCA -- NATIONAL PAINT AND COATINGS ASSOCIATION  
2.135 NRCA -- NATIONAL ROOFING CONTRACTORS ASSOCIATION  
2.136 NSF -- NSF INTERNATIONAL (THE PUBLIC HEALTH AND SAFETY ORGANIZATION)  
2.137 NTMA -- NATIONAL TERRAZZO AND MOSAIC ASSOCIATION, INC., THE  
2.138 NTMA -- NATIONAL TILE AND MARBLE ASSOCIATION  
2.139 NWFA -- NATIONAL WOOD FLOORING ASSOCIATION  
2.140 NWWDA -- NATIONAL WOOD WINDOW AND DOOR ASSOCIATION (NAME CHANGED TO  
WDMA)  
2.141 OWMA -- OPERABLE WALL MANUFACTURERS ASSOCIATION  
2.142 PCA -- PORTLAND CEMENT ASSOCIATION  
2.143 PCI -- PRECAST/PRESTRESSED CONCRETE INSTITUTE  
2.144 PDCA -- PAINTING AND DECORATING CONTRACTORS OF AMERICA  
2.145 PDI -- PLUMBING AND DRAINAGE INSTITUTE  
2.146 PECI - PORTLAND ENERGY CONSERVATION, INC.  
2.147 PEI -- PORCELAIN ENAMEL INSTITUTE  
2.148 PPI -- PLASTICS PIPE INSTITUTE  
2.149 PTI -- POST-TENSIONING INSTITUTE  
2.150 RCSC -- RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS  
2.151 RIS -- REDWOOD INSPECTION SERVICE  
2.152 RFCI -- RESILIENT FLOOR COVERING INSTITUTE  
2.153 RTI - ROOF TILE INSTITUTE

- 2.154 SCTE -- SOCIETY OF CABLE TELECOMMUNICATIONS ENGINEERS
- 2.155 SDI -- STEEL DECK INSTITUTE
- 2.156 SDI -- STEEL DOOR INSTITUTE
- 2.157 SEFA -- SCIENTIFIC EQUIPMENT AND FURNITURE ASSOCIATION
- 2.158 SIGMA -- SEALED INSULATING GLASS MANUFACTURERS ASSOCIATION (SEE IGMA)
- 2.159 SJI -- STEEL JOIST INSTITUTE
- 2.160 SMA -- STUCCO MANUFACTURERS ASSOCIATION, INC.
- 2.161 SMACNA -- SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.
- 2.162 SPIB -- SOUTHERN PINE INSPECTION BUREAU, INC.
- 2.163 SPRI -- SINGLE PLY ROOFING INDUSTRY
- 2.164 SRI -- STEEL RECYCLING INSTITUTE
- 2.165 SSPC -- SOCIETY FOR PROTECTIVE COATINGS
- 2.166 SWI -- STEEL WINDOW INSTITUTE
- 2.167 SWRI -- SEALANT, WATERPROOFING AND RESTORATION INSTITUTE
- 2.168 TCNA -- TILE COUNCIL OF NORTH AMERICA, INC.
- 2.169 TIA -- TELECOMMUNICATIONS INDUSTRY ASSOCIATION
- 2.170 TPI -- TRUSS PLATE INSTITUTE
- 2.171 TPI -- TURFGRASS PRODUCERS INTERNATIONAL
- 2.172 UL -- UNDERWRITERS LABORATORIES INC.
- 2.173 USGBC -- U. S. GREEN BUILDING COUNCIL
- 2.174 WCLIB -- WEST COAST LUMBER INSPECTION BUREAU
- 2.175 WCMA -- WINDOW COVERING MANUFACTURERS ASSOCIATION
- 2.176 WDMA -- WINDOW AND DOOR MANUFACTURERS ASSOCIATION (FORMERLY NWWDA)
- 2.177 WI -- WOODWORK INSTITUTE
- 2.178 WMMPA -- WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION
- 2.179 WRCLA -- WESTERN RED CEDAR LUMBER ASSOCIATION
- 2.180 WWPA -- WESTERN WOOD PRODUCTS ASSOCIATION

### **PART 3 UNITED STATES GOVERNMENT AND RELATED AGENCIES DOCUMENTS**

#### **3.01 CFR -- CODE OF FEDERAL REGULATIONS**

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.

- 3.02 ATBCB -- US ARCHITECTURAL AND TRANSPORTATION BARRIERS COMPLIANCE BOARD (THE ACCESS BOARD)
- 3.03 EPA -- ENVIRONMENTAL PROTECTION AGENCY
- 3.04 FDA -- FOOD AND DRUG ADMINISTRATION
- 3.05 FS -- FEDERAL SPECIFICATIONS AND STANDARDS (GENERAL SERVICES ADMINISTRATION)
- 3.06 NIJ -- NATIONAL INSTITUTE OF JUSTICE (DEPT. OF JUSTICE)
- 3.07 PS -- PRODUCT STANDARDS
- 3.08 USGS -- UNITED STATES GEOLOGICAL SURVEY

**END OF SECTION**

**SECTION 01 50 00**  
**TEMPORARY FACILITIES AND CONTROLS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Temporary sanitary facilities.
- B. Temporary Controls: Barriers, enclosures, and fencing.
- C. Security requirements.
- D. Vehicular access and parking.
- E. Waste removal facilities and services.
- F. Project identification sign.
- G. Field offices.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 51 00 - Temporary Utilities.

**1.03 REFERENCE STANDARDS**

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

**1.04 QUALITY ASSURANCE**

- A. Regulations: Comply with industry standards and applicable laws and regulations if authorities having jurisdiction, including but not limited to:
  - 1) Building Code requirements.
  - 2) Health and safety regulations.
  - 3) Police, Fire Department and Rescue Squad rules.
  - 4) Environmental protection regulations.
- B. Standards: Comply with NFPA Code 241, "Building Construction and Demolition Operations", ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition".

**1.05 TEMPORARY UTILITIES - SEE SECTION 01 51 00**

**1.06 TEMPORARY SANITARY FACILITIES**

- A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
- B. Maintain daily in clean and sanitary condition.

**1.07 SECURITY AND PROTECTION FACILITIES INSTALLATION**

- A. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from person or firms near the site.

**1.08 BARRIERS**

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

- B. Provide protection for plants designated to remain. Replace damaged plants.
- C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

#### **1.09 FENCING**

- A. Provide 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks. Extent of security fence to be coordinated with Owner.

#### **1.10 SECURITY**

- A. Provide security and facilities to protect Work, and UCCS's operations from unauthorized entry, vandalism, or theft.
- B. Coordinate with UCCS's security program.

#### **1.11 VEHICULAR ACCESS AND PARKING**

- A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.
- B. Coordinate access and haul routes with governing authorities and UCCS.
- C. Provide and maintain access to fire hydrants, free of obstructions.
- D. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.
- E. Review parking location(s) with UCCS during preconstruction meeting or as noted on Contract Drawings.

#### **1.12 TEMPORARY CONTROLS**

- A. Dust: See Section 01 70 00 - Execution and Closeout Requirements.

#### **1.13 WASTE REMOVAL**

- A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- B. Provide containers with lids. Remove trash from site periodically.
- C. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

#### **1.14 PROJECT IDENTIFICATION**

- A. Provide project identification sign of design, construction, and location approved by UCCS and Architect.
- B. No other signs are allowed without UCCS permission except those required by law.

#### **1.15 FIELD OFFICES**

- A. Office: Weathertight, with lighting, electrical outlets, heating, cooling and ventilating equipment, and equipped with sturdy furniture and drawing display table.
- B. Provide space for Project meetings, with table and chairs to accommodate 6 persons.
- C. Locate offices a minimum distance of 100 feet from existing and new structures.

#### **1.16 FIRE EXTINGUISHERS**

- A. Provide hand-carried, portable UL-rated, class "A" fire extinguisher for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
  - 1) Comply with NFPA 10 and 241 for classification, extinguishing agent and sizes required by location and class of fire exposure.



**1.17 DRINKING WATER**

- A. Provide containerized tap-dispense bottled-water type drinking water units, including paper supply.

**1.18 FIRST AID SUPPLIES**

- A. Comply with governing regulations.

**1.19 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS**

- A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary work.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION - NOT USED**

**END OF SECTION**



## SECTION 01 51 00 TEMPORARY UTILITIES

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Temporary Utilities: Electricity, lighting, heat, ventilation, and water.

#### 1.02 RELATED REQUIREMENTS

- A. Section 01 50 00 - 01 50 00:
  - 1) Temporary sanitary facilities required by law.

#### 1.03 QUALITY ASSURANCE

- A. Regulations: Comply with industry standards and applicable laws and regulations if authorities having jurisdiction, including but not limited to:
  - 1) Building Code requirements.
  - 2) Health and safety regulations.
  - 3) Utility company regulations.
  - 4) Police, Fire Department and Rescue Squad rules.
  - 5) Environmental protection regulations.
- B. Standards: Comply with NFPA Code 241, "Building Construction and Demolition Operations", ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition", and NECA Electrical Design Library "Temporary Electrical Facilities."
  - 1) Refer to "Guidelines for Bid Conditions for Temporary Job Utilities and Services", prepared jointly by AGC and ASC, for industry recommendations.
  - 2) Electrical Service: Comply with NEMA, NECA and UL standards and regulations for temporary electric service. Install service in compliance with National Electric Code (NFPA 70).
- C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

#### 1.04 TEMPORARY UTILITY INSTALLATION

- A. General: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
  - 1) Arrange with the company and existing users for a time when service can be interrupted, where necessary, to make connections for temporary services.
  - 2) Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.
  - 3) Obtain easements to bring temporary utilities to the site, where the Owner's easements cannot be used for that purpose.
  - 4) Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Architect, and will not be accepted as a basis of claims for a Change Order.

#### 1.05 TEMPORARY ELECTRICITY

- A. Cost: By Contractor.
- B. Provide power service required from utility source.
  - 1) Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period.

Include meters, transformers, overload protected disconnects, automatic ground-fault interrupters and main distribution switch gear.

- C. Power Service Characteristics: 125 volt, AC 20 ampere, three phase, four wire.
- D. Provide power outlets for construction operations, with branch wiring and distribution boxes located at each floor. Provide flexible power cords as required.
- E. Provide main service disconnect and over-current protection at convenient location and meter.
- F. Permanent convenience receptacles may not be utilized during construction.
- G. Provide adequate distribution equipment, wiring, and outlets to provide single phase branch circuits for power and lighting.
- H. Electrical Power Cords: Provide grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas where construction activities are in progress.
- I. The Temporary Electrical Power Service shall remain in place for the duration of the entire Project and shall be removed by the Contractor.

#### **1.06 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES**

- A. Provide and maintain incandescent lighting for construction operations .
  - 1) Install and operate temporary lighting that will fulfill security and protection requirements, without operating the entire system, and will provide adequate illumination for construction operations and traffic conditions.
  - 2) Provide guard cages of tempered glass enclosures, where exposed to breakage.
  - 3) Provide exterior fixtures where exposed to moisture.
- B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- C. Maintain lighting and provide routine repairs.

#### **1.07 TEMPORARY HEATING**

- A. Cost of Energy: By Contractor.
- B. Provide heating devices and heat as needed to maintain specified conditions for construction operations.
  - 1) Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.
  - 2) Provide vented self-contained LP gas or fuel oil heaters with individual space thermostatic control.
    - a. Use of gasoline-burning space heaters, open flame, or salamander type heating units is prohibited.
- C. Maintain minimum ambient temperature of 50 degrees F in areas where construction is in progress, unless indicated otherwise in specifications.
- D. Existing facilities shall not be used.

#### **1.08 TEMPORARY WATER SERVICE**

- A. Cost of Water Used: By Contractor.
- B. Provide and maintain suitable quality water service for construction operations at time of project mobilization.
- C. Connect to existing water source.
  - 1) Provide separate metering and reimburse UCCS for cost of water used.

PART 2 PRODUCTS - NOT USED  
PART 3 EXECUTION - NOT USED

END OF SECTION



## SECTION 01 60 00 PRODUCT REQUIREMENTS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. General product requirements.
- B. Transportation, handling, storage and protection.
- C. Product option requirements.
- D. Installation
- E. Substitution limitations and procedures.

#### 1.02 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements.
- B. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.
- C. Section 01 70 00 - Execution and Closeout Requirements: Pre-installation conference.
- D. Section 01 78 00 - Closeout Procedures" Submittals for closeout including O&M manuals and warranties.

#### 1.03 REFERENCE STANDARDS

- A. CAN/CSA Z809 - National Standard for Sustainable Forest Management; CSA International Inc; 2008.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

#### 1.04 DEFINITIONS

- A. Definitions used in this Article are not intended to change the meaning of other terms used in the Contract Documents such as "specialties", "systems", "structure", "finishes", "accessories", and similar terms. Such terms are self-explanatory and have well recognized meanings in the construction industry.
  - 1) "Products" are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "material", "equipment", "system", and terms of similar intent.
    - a. "Named Products" are items identified by manufacturer's product name including make or model designation indicated in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
    - b. "Foreign Products", as distinguished from "domestic products", are items substantially manufactured (50 percent or more of value) outside of the United States and its possessions; or produced by persons who are not citizens or nor living within the United States and its possessions.
  - 2) "Materials" are products that are substantially shaped, cut, worked, mixed, finished, refined; or otherwise fabricated, processed, or installed to form a part of the Work.
  - 3) "Equipment" is a product with operational parts, whether motorized or manually operated, that requires service connections such as wiring or piping.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

#### **1.05 SUBMITTALS**

- A. See Section 01 33 00, "Submittal Procedures".
- B. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- C. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- D. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
  - 1) For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

### **PART 2 PRODUCTS**

#### **2.01 NEW PRODUCTS**

- A. Provide new products unless specifically required or permitted by the Contract Documents.
- B. DO NOT USE products having any of the following characteristics:
  - 1) Made using or containing CFC's or HCFC's.
  - 2) Made of wood from newly cut old growth timber.
  - 3) Containing lead, cadmium, asbestos.
- C. Where all other criteria are met, Contractor shall give preference to products that:
  - 1) If used on interior, have lower emissions, as defined in Section 01 61 16.
  - 2) If wet-applied, have lower VOC content, as defined in Section 01 61 16.

#### **2.02 PRODUCT OPTIONS**

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.
  - 1) Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.



- 2) Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

### **PART 3 EXECUTION**

#### **3.01 SUBSTITUTION PROCEDURES**

- A. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- B. A request for substitution constitutes a representation that the submitter:
  - 1) Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
  - 2) Agrees to provide the same warranty for the substitution as for the specified product.
  - 3) Agrees to coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to UCCS.
  - 4) Waives claims for additional costs or time extension that may subsequently become apparent.
  - 5) Agrees to reimburse UCCS and Architect for review or redesign services associated with re-approval by authorities.
- C. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

#### **3.02 TRANSPORTATION AND HANDLING**

- A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
- B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.
- C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- D. Transport and handle products in accordance with manufacturer's instructions.
- E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- G. Unloading: Each subcontractor is responsible for unloading, hoisting and stocking of his materials and equipment on site.
- H. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
- I. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

#### **3.03 STORAGE AND PROTECTION**

- A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.

- D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.
- G. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- H. Comply with manufacturer's warranty conditions, if any.
- I. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- J. Prevent contact with material that may cause corrosion, discoloration, or staining.
- K. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- L. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

### 3.04 INSTALLATION

- A. See Section 01 70 00 - Execution and Closeout Requirements for preinstallation meeting.
- B. Inspection of Substrates: Require installer of each major unit of Work to inspect substrate to receive Work and conditions under which Work is to be performed.
  - 1) Installer: Report unsatisfactory conditions to General Contractor in writing with copy to Architect.
  - 2) Do not proceed with Work until unsatisfactory conditions have been corrected to satisfaction of installer.
- C. Manufacturer's Instructions: Where installations include manufactured products, comply with manufacturer's applicable instructions and recommendations for installation, to extent that these instructions and recommendations are more explicit or more stringent than requirements specified or indicated.
  - 1) Notify Architect of any conflicts between manufacturer's instruction or recommendations and requirements specified or indicated.
- D. Attachment: Provide attachment and connection devices and methods for securing Work.
  - 1) Secure Work true to line and level, and within specified tolerances, or if not specified, industry recognized tolerances.
  - 2) Allow for expansion and building movement.
  - 3) Exposed Joints:
    - a. Provide uniform joint width.
    - b. Arrange joint to obtain best visual effect.
    - c. Refer questionable visual-effect choices to Architect for final decision.
- E. Measurements and Dimensions: Recheck as integral step of starting each installation.
- F. Climatic Conditions and Project Status: Install each unit of Work under conditions to ensure best possible results in coordination with entire project.
  - 1) Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
  - 2) Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.

- G. Mounting Heights: Where not indicated, mount individual units of Work at ADA standards or industry recognized standard mounting heights for particular application indicated. Refer questionable mounting heights choices to Architect for final decision.

**END OF SECTION**



## SECTION 01 61 16

### VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Requirements for VOC-Content-Restricted products.

##### 1.02 RELATED REQUIREMENTS

- A. Section 01 33 00 - Submittal Procedures.
- B. Section 01 40 00 - Quality Requirements: Procedures for certifications.
- C. Section 01 60 00 - Fundamental product requirements, substitutions and product options, delivery, storage, and handling.
- D. Section 07 92 00 - Joint Sealants: Emissions-compliant sealants.
- E. Section 09 91 13 - Exterior Painting: Emissions compliant pint products.

##### 1.03 DEFINITIONS

- A. VOC-Content-Restricted Products: All products in the following product categories, whether specified or not:
  - 1) Exterior and interior paints and coatings.
  - 2) Exterior and interior adhesives and sealants, including flooring adhesives.
- B. Adhesives: All gunnable, trowelable, liquid-applied, and aerosol adhesives, whether specified or not; including flooring adhesives, resilient base adhesives, and pipe jointing adhesives.
- C. Sealants: All gunnable, trowelable, and liquid-applied joint sealants and sealant primers, whether specified or not; including firestopping sealants and duct joint sealers.

##### 1.04 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.
- B. ASTM D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings; 2005 (Reapproved 2013).
- C. CARB (SCM) - Suggested Control Measure for Architectural Coatings; California Air Resources Board; 2007.
- D. SCAQMD 1113 - South Coast Air Quality Management District Rule No.1113; current edition.
- E. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition.

##### 1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. Product Data: For each VOC-restricted product used in the project, submit evidence of compliance.

##### 1.06 QUALITY ASSURANCE

- A. VOC Content Test Method: 40 CFR 59, Subpart D (EPA Method 24), or ASTM D3960, unless otherwise indicated.
  - 1) Evidence of Compliance: Acceptable types of evidence are:
    - a. Report of laboratory testing performed in accordance with requirements.

- B. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. VOC-Content-Restricted Products: VOC content not greater than required by the following:
  - 1) Adhesives, Including Flooring Adhesives: SCAQMD 1168 Rule.
  - 2) Joint Sealants: SCAQMD 1168 Rule.
  - 3) Paints and Coatings: Each color; most stringent of the following:
    - a. 40 CFR 59, Subpart D.
    - b. SCAQMD 1113 Rule.
    - c. CARB (SCM).

## **PART 3 EXECUTION**

### **3.01 FIELD QUALITY CONTROL**

- A. UCCS reserves the right to reject non-compliant products, whether installed or not, and require their removal and replacement with compliant products at no extra cost to UCCS.
- B. Additional costs to restore indoor air quality due to installation of non-compliant products will be borne by Contractor.

**END OF SECTION**

**SECTION 01 70 00**  
**EXECUTION AND CLOSEOUT REQUIREMENTS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Examination, preparation, and general installation procedures.
- B. Requests for Information.
- C. Cutting and patching.
- D. Cleaning and protection.
- E. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 30 00 - Administrative Requirements: Submittals procedures .
- B. Section 01 40 00 - Quality Requirements: Testing and inspection procedures.
- C. Section 01 51 00 - Temporary Utilities: Temporary heating, cooling, and ventilating facilities.
- D. Section 01 78 00 - Closeout Submittals: Project record documents, operation and maintenance data, warranties .
- E. Individual Product Specification Sections:
  - 1) See individual product sections for pre-installation meeting requirement.

**1.03 REFERENCE STANDARDS**

- A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2013.

**1.04 SUBMITTALS**

- A. See Section 01 33 00, "Submittal Procedures".
- B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
  - 1) Structural integrity of any element of Project.
  - 2) Integrity of weather exposed or moisture resistant element.
  - 3) Efficiency, maintenance, or safety of any operational element.
  - 4) Visual qualities of sight exposed elements.
  - 5) Include in request:
    - a. Identification of Project.
    - b. Location and description of affected work.
    - c. Necessity for cutting or alteration.
    - d. Description of proposed work and products to be used.
    - e. Alternatives to cutting and patching.
    - f. Written permission of affected separate Contractor.
    - g. Date and time work will be executed.

**1.05 PROJECT CONDITIONS**

- A. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
- B. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.

- 1) Outdoors: Limit conduct of especially noisy exterior work to the hours of 8 am to 5 pm.
- C. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

## **1.06 COORDINATION**

- A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Notify affected utility companies and comply with their requirements.
- C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean-up of work of separate sections.

## **PART 2 PRODUCTS**

### **2.01 PATCHING MATERIALS**

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.



### **3.02 PREPARATION**

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

### **3.03 GENERAL INSTALLATION REQUIREMENTS**

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.

### **3.04 REQUESTS FOR INFORMATION (RFIS)**

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI.
  - 1) Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
  - 2) Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
  - 1) Project name.
  - 2) Project number.
  - 3) Date and requested return date.
  - 4) Name of Contractor.
  - 5) Name of Architect and General Contractor.
  - 6) RFI number, numbered sequentially.
  - 7) RFI subject.
  - 8) Specification Section number and title and related paragraphs, as appropriate.
  - 9) Drawing number and detail references, as appropriate.
  - 10) Field dimensions and conditions, as appropriate.
  - 11) Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  - 12) Contractor's signature.
  - 13) Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: General Contractor Software-generated form with substantially the same content as indicated above, acceptable to Architect.
  - 1) Attachments shall be in electronic format.

- D. Architect's Action: Architect will review each RFI, determine action required, forward to appropriate consultant for response, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
- 1) The following Contractor-generated RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for approval of Contractor's means and methods.
    - d. Requests for coordination information already indicated in the Contract Documents.
    - e. Requests for adjustments in the Contract Time or the Contract Sum.
    - f. Requests for interpretation of Architect's actions on submittals.
    - g. Incomplete RFIs or inaccurately prepared RFIs.
  - 2) Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
  - 3) If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Owner in writing within 10 days of receipt of the RFI response.

### 3.05 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. Perform whatever cutting and patching is necessary to:
  - 1) Complete the work.
  - 2) Fit products together to integrate with other work.
  - 3) Provide openings for penetration of mechanical, electrical, and other services.
  - 4) Match work that has been cut to adjacent work.
  - 5) Repair areas adjacent to cuts to required condition.
  - 6) Repair new work damaged by subsequent work.
  - 7) Remove samples of installed work for testing when requested.
  - 8) Remove and replace defective and non-conforming work.
- C. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing.
- D. Employ skilled and experienced installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- F. Restore work with new products in accordance with requirements of Contract Documents.
- G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.
- I. Patching:
  - 1) Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
  - 2) Match color, texture, and appearance.

- 3) Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

### **3.06 PROGRESS CLEANING**

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

### **3.07 PROTECTION OF INSTALLED WORK**

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle plastic coverings if possible.

### **3.08 FINAL CLEANING**

- A. Execute final cleaning after Substantial Completion but before making final application for payment.
- B. Use cleaning materials that are nonhazardous.
- C. Clean debris from roofs, overflow drains, and area drains.
- D. Clean site; sweep paved areas, rake clean landscaped surfaces.
- E. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

### **3.09 CLOSEOUT PROCEDURES**

- A. Make submittals that are required by governing or other authorities.
  - 1) Provide copies to Architect and UCCS.
- B. When the Contractor believes that all work is complete, the Contractor shall personally inspect the work to certify completion of all contract requirements. The Contractor shall then notify the Architect, IN WRITING, of project completion, and list outstanding or incomplete items required by the contract. Such written notification shall constitute the Contractor's certification of inspection, acceptance, and suitability of the work for the Architect's review. Before requesting an inspection, the Contractor shall have submitted to the Architect:
  - 1) All shop drawings, submittals and product data as required by the Contract Documents.

- 2) All reports as required by the Contract Documents.
  - 3) Inspection reports and certificates of agencies having jurisdiction.
  - 4) Price quotations for any outstanding change orders, bulletins, or claims.
  - 5) Schedule and perform all training required by the Contract Documents.
- C. The Contractor shall notify all applicable regulatory agencies that the project is complete and ready for final inspection, etc. Notifications shall include:
- 1) Any agencies having jurisdiction.
- D. Within five (5) days of receipt of a request for inspection (and all required submittals and report(s)), the Architect will schedule a final inspection. The inspection will be attended by the Architect, the General Contractor and major Trade-Contractors. A punch-list of work to be accomplished before acceptance of the project will be prepared by the Architect and distributed to all concerned parties.
- E. Unless otherwise arranged, at the time of final inspection the Contractor shall provide all keys at the project site. A full inspection of all locks and keying will be conducted by the Contractor and Owner. At the completion of the Keying Inspection, all keys will be turned over to the Owner.
- F. Within 30 calendar days of the issuance of the final punch list, the Contractor shall have completed all punch list items.
- G. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.
- H. Correct items of work listed in Final Correction Punch List and comply with requirements for access to UCCS-occupied areas.
- I. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.
- J. The Contractor shall submit to the Architect at time of request for Final Completion:
- 1) All Guarantees and Warranties required by the Contract Documents. All Guarantees and Warranties shall bear the effective date of the recommended date of acceptance as established by the Architect.
  - 2) Final Application for Payment.
  - 3) No additional payments will be made if certificate of occupancy (or certificate of compliance) has not been provided.
  - 4) Consent of surety to final payment.
  - 5) Operating and maintenance manuals for all equipment and products as required by the Contract Documents.

### **3.10 MAINTENANCE**

- A. See Section 01 78 00 - Closeout Submittals for operation and maintenance information.

### **END OF SECTION**

## SECTION 01 78 00 CLOSEOUT SUBMITTALS

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Project Record Documents.
- B. Operation and Maintenance Data.
- C. Warranties and bonds.

#### 1.02 RELATED REQUIREMENTS

- A. Section 01 33 00 - Submittal Procedures.
- B. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- C. Section 01 70 00 - Contract closeout procedures.
- D. Individual Product Sections: Specific requirements for operation and maintenance data.
- E. Individual Product Sections: Warranties required for specific products or Work.

#### 1.03 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures.
- B. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
- C. Operation and Maintenance Data:
  - 1) Format: Submit operations and maintenance manuals in the following format:
    - a. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
      - 1) Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically bookmarked and linked operation and maintenance directory.
      - 2) Enable inserted reviewer comments on draft submittals.
    - 2) Initial Manual Submittal: Submit draft copy of each manual at least 15 days before commencing demonstration and training. Architect and Commissioning Authority will comment on whether general scope and content of manual are acceptable.
    - 3) Final Manual Submittal: Submit each manual in final form prior to requesting final payment.
      - a. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments.
- D. Warranties and Bonds:
  - 1) For equipment or component parts of equipment put into service during construction with UCCS's permission, submit documents within 10 days after acceptance.
  - 2) Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
  - 3) For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.
  - 4) Guarantee and Warranty certificates shall be included with the Operation and Maintenance Manuals submittal as indicated in Part 3 of this Section.

## **PART 2 PRODUCTS**

### **2.01 GENERAL CONTRACTOR TWELVE MONTH GUARANTEE OF MATERIALS AND WORKMANSHIP**

- A. The Contractor shall guarantee in writing to the Owner that all work performed and all materials and equipment furnished under this contract are new and in accordance with the Contract Documents, are free from defects in equipment, materials or design furnished, or workmanship performed by the Contractor or any of his subcontractors or suppliers at any tier. Such guarantee shall continue for a period of twelve (12) months from the date of Substantial Completion of the work.
- B. Under this guarantee, the Contractor shall agree to remedy at his own expense any inferior or defective equipment, materials, workmanship, or design that should develop during the guarantee period, or in restoring any other work damaged in fulfilling the terms of the guarantee.
- C. The Contractor shall not perform any work that shall void any Manufacturer Guarantee and Warranty.

### **2.02 MANUFACTURER GUARANTEE AND WARRANTY**

- A. As identified in other Sections of these Specifications, the Contractor shall provide written manufacturer's guarantees and/or warranties for specific materials, products, and equipment furnished under this contract.
- B. Such guarantees and warranties shall be valid for the period of time stated in each applicable specification from the date of Substantial Completion of the work but not less than twelve (12) months.

### **2.03 EXTENDED WARRANTIES**

- A. As identified in other Sections of these Specifications, the Contractor shall provide written manufacturer's guarantees and/or warranties for specific materials, products, and equipment furnished and installed under this Contract.
- B. Such guarantees/warranties shall be valid for the stated extended period beyond twelve (12) months from the date of Substantial Completion of the work.

### **2.04 EXCLUSIONS**

- A. Warranty requirements contained in these Specifications take precedence. Exclusion clauses shall be superseded by warranty coverage requirements of the Specifications.
- B. The Contractor shall notify the Architect of design conditions which cannot be fully warranted. Such notice shall be in writing prior to purchase of the affected product or system.
- C. Failure to provide such notice shall not be grounds for waiver of warranty requirements contained in the Specifications.
- D. Upon receipt of such notice, the Architect will consider modifications necessary to assure that final construction is warrantable to the full extent of Contract requirements.

## **PART 3 EXECUTION**

### **3.01 PROJECT RECORD DOCUMENTS**

- A. Project Site Record Documents: Maintain at project site an electronic file of the project for the purpose of recording as-built conditions:
  - 1) Contract Drawings.
  - 2) Specifications.
  - 3) Addenda.
  - 4) Approved Shop Drawings, Product Data, and Samples.
  - 5) Change Orders.

- 6) Other Modifications to Contract.
  - 7) Other approved documents submitted by the Contractor in compliance with specification requirements.
- B. Record Documents: These Documents shall be accurately marked with all changes made during construction. As-built notes shall be made electronically in the electronic file.
  - C. Project record documents shall be available at all times for review of the Architect or Owner.

### **3.02 OPERATION AND MAINTENANCE DATA**

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

### **3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES**

- A. For Each Product, Applied Material, and Finish:
  - 1) Product data, with catalog number, size, composition, and color and texture designations.
  - 2) Information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
- C. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

### **3.04 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS**

- A. Assemble operation and maintenance data into durable manuals for UCCS's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
- B. Where systems involve more than one specification section, provide separate tabbed divider for each system.
- C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.

- F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.
- G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.
- H. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.
- I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- J. Arrangement of Contents: Organize each volume in parts as follows:
  - 1) Project Directory.
  - 2) Table of Contents, of all volumes, and of this volume.
  - 3) Operation and Maintenance Data: Arranged by system, then by product category.
    - a. Source data.
    - b. Product data, shop drawings, and other submittals.
    - c. Operation and maintenance data.
    - d. Field quality control data.
    - e. Photocopies of warranties and bonds.

### **3.05 WARRANTIES AND BONDS**

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with UCCS's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.
- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Co-execute submittals when required.
- D. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  - 1) Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
    - a. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.
  - 2) Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
    - a. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
    - b. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
    - c. Refer to Divisions 2 through 33 for specific content requirements and particular requirements for submitting special warranties.
- E. Retain warranties and bonds until time specified for submittal.
- F. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.



- G. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor ; and name of responsible company principal.
- H. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.
- I. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

**END OF SECTION**



## SECTION 01 79 00 DEMONSTRATION AND TRAINING

### PART 1 GENERAL

#### 1.01 SUMMARY

- A. Demonstration of products and systems to be commissioned and where indicated in specific specification sections.
- B. Training of UCCS personnel in operation and maintenance is required for:
  - 1) HVAC systems and equipment.
  - 2) Plumbing equipment.
  - 3) Electrical systems and equipment.
  - 4) Items specified in individual product Sections.
- C. Training of UCCS personnel in care, cleaning, maintenance, and repair is required for:
  - 1) Roofing, waterproofing, and other weather-exposed or moisture protection products.
  - 2) Finishes, including flooring, wall finishes, ceiling finishes.
  - 3) Fixtures and fittings.
  - 4) Items specified in individual product Sections.

#### 1.02 RELATED REQUIREMENTS

- A. Section 01 78 00 - Closeout Submittals: Operation and maintenance manuals.
- B. Section 01 91 13 - General Commissioning Requirements: Additional requirements applicable to demonstration and training.
- C. Other Specification Sections: Additional requirements for demonstration and training.

#### 1.03 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures for submittal procedures except:
  - 1) Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Authority.
  - 2) Submit one copy to the Commissioning Authority, not to be returned.
  - 3) Make commissioning submittals on time schedule specified by Commissioning Authority.
  - 4) Submittals indicated as "Draft" are intended for the use of the Commissioning Authority in preparation of overall Training Plan; submit in editable electronic format, Microsoft Word 2003 or greater. Coordinate with Commissioning Authority.
- B. Draft Training Plans: UCCS will designate personnel to be trained; tailor training to needs and skill-level of attendees.
  - 1) Submit to Commissioning Authority for review and inclusion in overall training plan.
  - 2) Submit not less than four weeks prior to start of training.
  - 3) Revise and resubmit until acceptable.
  - 4) Provide an overall schedule showing all training sessions.
  - 5) Include at least the following for each training session:
    - a. Identification, date, time, and duration.
    - b. Description of products and/or systems to be covered.
    - c. Name of firm and person conducting training; include qualifications.
    - d. Intended audience, such as job description.
    - e. Objectives of training and suggested methods of ensuring adequate training.
    - f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.

- g. Media to be used, such as slides, hand-outs, etc.
  - h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
- C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
- 1) Include applicable portion of O&M manuals.
  - 2) Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
  - 3) Provide one extra copy of each training manual to be included with operation and maintenance data.

#### **1.04 QUALITY ASSURANCE**

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
- 1) Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
  - 2) Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

#### **PART 2 PRODUCTS - NOT USED**

#### **PART 3 EXECUTION**

##### **3.01 DEMONSTRATION - GENERAL**

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by UCCS.
- B. Demonstrations conducted during Functional Testing need not be repeated unless UCCS personnel training is specified.
- C. Demonstration may be combined with UCCS personnel training if applicable.
- D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
- 1) Perform demonstrations not less than two weeks prior to Substantial Completion.
  - 2) For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- E. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
- 1) Perform demonstrations not less than two weeks prior to Substantial Completion.

##### **3.02 TRAINING - GENERAL**

- A. Commissioning Authority will prepare the Training Plan based on draft plans submitted.
- B. Conduct training on-site unless otherwise indicated.
- C. UCCS will provide classroom and seating at no cost to Contractor.
- D. Do not start training until Functional Testing is complete, unless otherwise specified or approved by the Commissioning Authority.
- E. Provide training in minimum two hour segments.
- F. The Commissioning Authority is responsible for determining that the training was satisfactorily completed and will provide approval forms.
- G. Training schedule will be subject to availability of UCCS's personnel to be trained; re-schedule training sessions as required by UCCS; once schedule has been approved by

UCCS failure to conduct sessions according to schedule will be cause for UCCS to charge Contractor for personnel "show-up" time.

- H. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
  - 1) The location of the O&M manuals and procedures for use and preservation; backup copies.
  - 2) Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
  - 3) Typical uses of the O&M manuals.
- I. Product- and System-Specific Training:
  - 1) Review the applicable O&M manuals.
  - 2) For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
  - 3) Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
  - 4) Provide hands-on training on all operational modes possible and preventive maintenance.
  - 5) Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
  - 6) Discuss common troubleshooting problems and solutions.
  - 7) Discuss any peculiarities of equipment installation or operation.
  - 8) Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
  - 9) Review recommended tools and spare parts inventory suggestions of manufacturers.
  - 10) Review spare parts and tools required to be furnished by Contractor.
  - 11) Review spare parts suppliers and sources and procurement procedures.
- J. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

## **END OF SECTION**



## **SECTION 02 41 00 DEMOLITION**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Selective building demolition excluding removal of hazardous materials and toxic substances.
- B. Selective demolition of built site elements.
- C. Selective demolition of building elements for alteration purposes.
- D. Abandonment and removal of existing utilities and utility structures.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 10 00 - 01 10 00: Limitations on Contractor's use of site and premises.
- B. Section 01 50 00 - 01 50 00: Site fences, security, protective barriers, and waste removal.
- C. Section 01 70 00 - 01 70 00: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.
- D. Section 31 10 00 - Site Clearing: Vegetation and existing debris removal.
- E. Refer to Contract Drawings for extent of site demolition work and erosion and sediment control.

#### **1.03 REFERENCE STANDARDS**

- A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2013.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

### **PART 2 PRODUCTS**

#### **2.01 MATERIALS**

- A. Infill Material: As indicated on Contract Drawings.

### **PART 3 EXECUTION**

#### **3.01 SCOPE**

- A. Removal of select portions of the building where indicated on the Contract Drawings.
- B. Remove paving and curbs as required to accomplish new work.
- C. Remove all other paving and curbs as indicated on drawings.
- D. Remove concrete slabs on grade as indicated on drawings.
- E. Remove fences and gates where indicated.
- F. Remove other items indicated as indicated on Contract Drawings.

#### **3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS**

- A. Comply with other requirements specified in Section 01 70 00.
- B. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.

- 1) Obtain required permits.
  - 2) Use of explosives is not permitted.
  - 3) Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
  - 4) Provide, erect, and maintain temporary barriers and security devices.
  - 5) Conduct operations to minimize effects on and interference with adjacent structures and occupants.
  - 6) Do not close or obstruct roadways or sidewalks without permit.
  - 7) Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
  - 8) Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.
- C. Do not begin removal until receipt of notification to proceed from UCCS.
- D. Do not begin removal until vegetation to be relocated has been removed and specified measures have been taken to protect vegetation to remain.
- E. Protect existing structures and other elements that are not to be removed.
- 1) Provide bracing and shoring.
  - 2) Prevent movement or settlement of adjacent structures.
  - 3) Stop work immediately if adjacent structures appear to be in danger.
- F. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- G. If hazardous materials are discovered during removal operations, stop work and notify Architect and UCCS; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.
- H. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

### **3.03 EXISTING UTILITIES**

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to UCCS.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to UCCS.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.
- H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.



### **3.04 SELECTIVE DEMOLITION FOR ALTERATIONS**

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
  - 1) Verify that construction and utility arrangements are as shown.
  - 2) Report discrepancies to Architect before disturbing existing installation.
  - 3) Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
- C. Remove existing work as indicated and as required to accomplish new work.
  - 1) Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
  - 2) Remove items indicated on drawings.
- D. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
  - 1) Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
  - 2) Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
  - 3) See Section 01 10 00 for other limitations on outages and required notifications.
  - 4) Verify that abandoned services serve only abandoned facilities before removal.
  - 5) Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- E. Protect existing work to remain.
  - 1) Prevent movement of structure; provide shoring and bracing if necessary.
  - 2) Perform cutting to accomplish removals neatly and as specified for cutting new work.
  - 3) Repair adjacent construction and finishes damaged during removal work.
  - 4) Patch as specified for patching new work.

### **3.05 DEBRIS AND WASTE REMOVAL**

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

**END OF SECTION**



## **SECTION 03 10 00**

### **CONCRETE FORMING AND ACCESSORIES**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.
- B. Form accessories.
- C. Form stripping.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 03 20 00 - Concrete Reinforcing.
- B. Section 03 30 00 - 03 30 00 - Cast-In-Place-Concrete.
- C. Section 32 13 13 - Concrete Paving: Formwork for exterior concrete.

##### **1.03 REFERENCE STANDARDS**

- A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; 2010.
- B. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).
- C. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2011.
- D. ACI 347R - Guide to Formwork for Concrete; 2014.

#### **PART 2 PRODUCTS**

##### **2.01 FORMWORK - GENERAL**

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct to provide resultant concrete that conforms to design with respect to shape, lines, and dimensions.
- C. Chamfer outside corners of beams, joists, columns, and walls where noted on Contract Drawings. 1-inch, 45° job cut wood or 1 inch 45° PVC for unexposed surfaces. Use PVC for exposed surfaces.
- D. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.
- E. Comply with relevant portions of ACI 347R, ACI 301, and ACI 318.

##### **2.02 FORMWORK MATERIALS**

- A. Foundation: (non exposed) Dressed lumber or plywood.
- B. Non-exposed Concrete: Plywood, steel, or dressed lumber.

##### **2.03 FORMWORK ACCESSORIES**

- A. Form Ties: Removable type, galvanized metal, fixed length, cone type, with waterproofing washer, free of defects that could leave holes larger than 1 inch in concrete surface.
- B. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
  - 1) Composition: Colorless mineral oil-based compound.
- C. Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber with zip-strip cap.

- D. Waterstops: Polyvinyl chloride, minimum 1,750 psi tensile strength, minimum 50 degrees F to plus 175 degrees F working temperature range, 6" inch wide, maximum possible lengths, ribbed profile, preformed corner sections, heat welded jointing. Provide waterstop 609 retro-fit PVC manufactured by Greenstreak.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Notification: Provide ample notice to Architect to allow for review of formwork surfaces that will provide finish surface of exposed concrete. Provide at least 24 hours notice before placing concrete to allow the structural engineer to observe formwork and reinforcement.
- B. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

#### **3.02 EARTH FORMS**

- A. Earth forms are not permitted.

#### **3.03 ERECTION - FORMWORK**

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.
- B. Embeds:
  - 1) Anchors, Inserts, Blockouts, and Built-in Items: Securely fasten anchor bolts, inserts, form blockouts, and other items built into concrete to formwork or hold in place with templates. Insertion into concrete after placing concrete is not allowed.
- C. Slabs on Grade:
  - 1) Where concrete slabs are deposited on earth, take care to obtain smooth level surface so slabs will be of uniform thickness as required throughout.
  - 2) Locate construction joints and control joints as indicated on drawings or if not indicated, Architect to approve Contractor's proposed locations. Joint spacing shall not exceed 36 times slab thickness (inches).
  - 3) Place joint forms in straight line flush with finished surface and in accordance with manufacturer's recommendations.
  - 4) Wire bottom alignment slots and bottom of key to metal support stakes.
  - 5) Do not extend reinforcement through joint form unless so noted on drawings.
  - 6) Sawed joints may be substituted for joint forms at contraction joints.
    - a. Provide sawed joints 1/4 of slab thickness in depth.
    - b. Cut alternate wire or welded wire fabric at sawed joints.
    - c. Time joint sawing properly with setting of concrete. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking.
- D. Footings:
  - 1) Lap forming with dressed lumber or plywood not allowed.
  - 2) Close gaps greater than ¼ inches between bottom of forms and soil surfaces at isolated over excavated depressions.
- E. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

#### **3.04 APPLICATION - FORM RELEASE AGENT**

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

### **3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS**

- A. Install waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement. Heat seal joints so they are watertight.

### **3.06 FORM REMOVAL**

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

**END OF SECTION**



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

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Reinforcing steel for cast-in-place concrete.
- B. Supports and accessories for steel reinforcement.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 30 00 - 03 30 00.
- C. Section 32 13 13 - Concrete Paving: Reinforcement for exterior concrete.

#### **1.03 REFERENCE STANDARDS**

- A. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).
- B. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2011.
- C. ACI SP-66 - ACI Detailing Manual; 2004.
- D. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement; 2015.
- E. ASTM A704/A704M - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement; 2006 (Reapproved 2011).
- F. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2015.
- G. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel; 2011.
- H. CRSI (DA4) - Manual of Standard Practice; 2009.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit product data with application and installation instructions for proprietary reinforcement accessories. Submit manufacturer's catalog, physical dimensions, installation instructions and ICBO reports on all mechanical connectors and dowel form-savers used to splice reinforcing.
- C. Shop Drawings: Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, placement of concrete reinforcement including spacing of bars and location of splices.
  - 1) Include all accessories specified and required to support reinforcement. List type, height, finish, number and location of all bar supports.
  - 2) Show locations of submitted and approved construction joints (with all required inserts, dowels, mechanical connectors, etc.) on the shop drawings. Show all splices of reinforcing, type of splice used and splice location. If lap splices are used, show length of lap. Show grade of all reinforcement used.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. General: Comply with Section 01 60 00.
  - 1) Unload and store reinforcing bars to keep clean. Store on timber skids while awaiting use.

## **PART 2 PRODUCTS**

### **2.01 REINFORCEMENT**

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 - 60,000 psi unless otherwise indicated.
  - 1) Closed Ties: ASTM A615, Grade 40 or 60 unless otherwise indicated.
  - 2) Bars to be welded: ASTM A706.
- B. Steel Welded Wire Reinforcement (WWR): Plain type; ASTM A1064/A1064M.
  - 1) Form: Flat Sheets.
  - 2) WWR Style: 4 x 8-W6 x W10.
- C. Supports For Reinforcement:
  - 1) Provide supports for reinforcement including bolsters, chairs, spacers, bars and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place within specified tolerances. Use wire bar-type supports complying with CRSI, Class 1 or 2, or 4000 psi precast concrete bar supports unless noted otherwise. Precast bar supports complying with CRSI type PB, 4000 psi, 6"x6" maximum, may be used for slabs-on-grade and bottom footing bars as approved by Architect.
    - a. Size, length, number and spacing of supports shall be sufficient to hold reinforcing in the proper position within specified tolerances. Supports shall be sufficient in number and in stiffness to prevent reinforcing from moving due to normal construction traffic and concrete placement.
    - b. Use supports with sand plates, masonite bases, horizontal runners or suitable devices for slabs-on-grade. Do not use supports with standard chair legs for slabs-on-grade. All material which are adjacent to or touch the exposed exterior face of concrete members (including tie wire), and all materials come in direct contact with coated bars, such as slab bolsters, high chairs, etc., shall be plastic coated. CRSI Class 1 plastic tipped supports may be used against exposed exterior surfaces provided the plastic extends at least ½" in from the edge of the formwork.
- D. Fibrous Reinforcement: Fiber mesh per specification Section 03 30 00, Part 2 or approved substitute.
- E. Reinforcement Accessories:
  - 1) Tie Wire: Annealed, minimum 16 gage, 0.0508 inch.
  - 2) Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.

### **2.02 FABRICATION**

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Reinforcement: Provide ample notice to Structural Engineer to allow for observation of in place concrete reinforcement before placing concrete.

### **3.02 PLACEMENT**

- A. General: Comply with general notes on structural drawings.
- B. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- C. Do not displace or damage vapor barrier where occurs.



- D. Bending:
  - 1) Bend reinforcement cold.
  - 2) Provide full-length bars, accurately bent to details.
  - 3) Do not field bend bars partially embedded in concrete except as indicated on the drawings or specifically permitted by the Structural Engineer.
- E. Placing:
  - 1) Place reinforcement accurately and hold firmly in place before and during the placing of concrete.
  - 2) Provide minimum concrete protective cover for reinforcement from the exterior face of members in accordance with ACI 318 and notes on drawings.
  - 3) Provide bar supports and spacers to place bars in the proper location and wire adequately at intersections to hold bars firmly in position while concrete is placed.
  - 4) Project dowels 40 diameters unless otherwise indicated. Wire bent dowels in place before pouring.
- F. Lap Splicing:
  - 1) Wherever it is necessary to splice reinforcement other than as indicated on drawings, character of splice shall be accepted by Structural Engineer on basis of allowable bond stress and stress in reinforcement at splice.
  - 2) Do not splice at points of maximum stress nor splice adjacent bars at same point.
  - 3) Where spliced, conform to notes on the drawings.
- G. Supports and Spacers:
  - 1) Provide supports properly spaced and with sufficient strength to carry loads of reinforcing steel and deposited concrete without collapsing or allowing bars to sag.
  - 2) Provide galvanized or plastic coated bar supports and spacers where they will be in contact with concrete surfaces exposed to weather.
  - 3) Do not use bar supports to support runways for concrete buggies or similar loads.
  - 4) Precast blocks used to support mats of bars only with acceptance of Architect.
- H. Lap Splicing:
  - 1) Wherever it is necessary to splice reinforcement other than as indicated on drawings, Structural Engineer shall accept character of splice on basis of stress in reinforcement at splice.
  - 2) Do not splice at points of maximum stress nor splice adjacent bars at same point.
  - 3) Where spliced, lap continuous bars 40 diameters, but not less than 12", unless otherwise indicated on drawings.
- I. Welded Connections: Comply with ANSI/AWS D1.4. Undercut bars are subject to rejection.

### **3.03 WELDED WIRE FABRIC**

- A. Installation:
  - 1) Lay welded wire fabric continuously, with edges and ends overlapping adjoining sheets minimum of one full mesh, plus 2', and not less than 6", tied and placed over all piping and conduit.
  - 2) Support fabric on bar supports at position indicated on drawings.
  - 3) Where required, construct bulkheads at construction joints and screeds to place fabric in proper position.

### **3.04 FIELD QUALITY CONTROL**

- A. Observation:

- 1) Coordinate scheduling of placement of concrete under Section 03 30 00, Cast-in-Place concrete, to allow sufficient time for Structural Engineer's observations of completed installation and for making any necessary adjustments to the reinforcing placement before delivery of concrete.

### **3.05 CLEANING**

- A. Reinforcement: Clean prior to placing concrete to remove scale, oil, ice, or other coatings that will destroy or reduce bond, including mortar from previous concrete pours.

**END OF SECTION**

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

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. Floors and slabs on grade.
- B. Concrete partial foundation wall.
- C. Joint devices associated with concrete work.
- D. Concrete curing.

#### 1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories: Forms and accessories for formwork.
- B. Section 03 20 00 - Concrete Reinforcing.
- C. Section 07 92 00 - Joint Sealants: Products and installation for sealants for saw cut joints and isolation joints in slabs.
- D. Section 32 13 13 - Concrete Paving: Sidewalks, curbs and gutters.

#### 1.03 REFERENCE STANDARDS

- A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; 2010.
- B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).
- C. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).
- D. ACI 302.1R - Guide for Concrete Floor and Slab Construction; 2004 (Errata 2007).
- E. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000.
- F. ACI 305R - Hot Weather Concreting; 2010.
- G. ACI 306R - Cold Weather Concreting; 2010.
- H. ACI 308R - Guide to Curing Concrete; 2001 (Reapproved 2008).
- I. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2011.
- J. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2015a.
- K. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2015.
- L. ASTM C150/C150M - Standard Specification for Portland Cement; 2015.
- M. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a.
- N. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2013.
- O. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2015.
- P. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2014.
- Q. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2004 (Reapproved 2013).

- R. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2011.

#### 1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
  - 1) For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
- C. Shop Drawings: Submit in accordance with Section 01 30 00.
- D. Mix Design: Not less than two weeks prior to placing any concrete, submit substantiating data for concrete mixes for acceptance in accordance with Section 01 30 00 and ACI 211.5R.
  - 1) Submit separate mix design for each type of concrete to be used in project.
  - 2) Submittal: Include following:
    - a. Mix identification designation.
    - b. Statement of intended use for mix.
    - c. Mix proportions, including admixtures.
    - d. Manufacturer's data and/or certifications verifying conformance of mix materials including admixtures with specified requirements.
    - e. Wet and dry unit weight.
    - f. Entrained air content.
    - g. Design slump.
    - h. Required average strength qualification data per ACI 301. Submit separate qualification data for each production facility that will supply concrete to the project.
    - i. Average qualification data (trial mix data or field test data per ACI 301. When field test data is used to qualify average strength, submit separate qualification data for each production facility that will supply concrete to project.
    - j. Separate design mixes are required for each strength and class of concrete, each change in type and/or quantity of mix materials including admixtures, each change in slump limits and each change in entrained air content.
    - k. Water/cementitious materials ratio.
    - l. Aggregate source
- E. Test Reports: Reports of control tests, special tests and core tests specified and distributed under Section 01 40 00, Quality Requirements.

#### 1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
- B. Testing Agency: All testing will be conducted by approved testing laboratory. See Field Quality Control - Part 3 and Section 01 40 00.
- C. Record of Work: Keep record listing time, location and date of placement of concrete for structure. Keep such record until completion of project and make available to Architect for examination at any time.
- D. Pre-Installation Conference: Before submittal of mix designs, hold conference with General Contractor's superintendent, independent testing laboratory, concrete formwork installer, reinforcement installer, concrete supplier, concrete installer, pumping equipment operator, and manufacturer(s) representative(s) in accordance

with Section 01 31 00. Also notify Architect and Structural Engineer of meeting at least 10 days in advance.

- 1) Discuss all matters pertaining to proper forming, reinforcement placement, concrete supply, concrete placing, concrete testing, and concrete curing.
  - 2) Take minutes and distribute to attending parties, Architect and Structural Engineer.
- E. Follow recommendations of ACI 305R when concreting during hot weather.
- F. Follow recommendations of ACI 306R when concreting during cold weather.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. General: Materials handling and batching shall conform to applicable provisions of ASTM C94.
- B. Hauling Time: Discharge concrete transmitted in truck mixer, agitator, or other transportation device within 1-1/2 hours after mixing water has been added.
- C. Extra Water:
- 1) Deliver concrete to site in exact quantities required by design mix.
  - 2) Should extra water be required for workability before depositing concrete and water/cement ratio of accepted mix design has not been exceeded, General Contractor's superintendent shall have sole authority to authorize addition of water. Any additional water added to mix after leaving batch plant shall be indicated on truck ticket and signed by person responsible.
  - 3) Where extra water is added to concrete it shall be mixed thoroughly for 40 revolutions of drum or 3-1/2 minutes at mixing speed, whichever is greater.
  - 4) Water may be added at the site only once for each batch.

#### **1.07 PROJECT CONDITIONS**

- A. Environmental Requirements:
- 1) Cold Weather Placement:
    - a. When for 3 successive days prior to concrete placement, average daily outdoor temperature falls below 40 degrees F or when average outdoor temperature is expected to drop below 40 degrees F on day of concrete placement, preparations, preparation, and curing of concrete shall comply with Standard Specifications for Cold Weather Concreting (ACI 306.1).
    - b. Minimum temperature of concrete upon delivery shall conform to Specifications for Structural Concrete (ACI 301) Section 4. Concrete temperature at placement shall conform to minimum values of ACI 306.1 Table 3.2.1, and shall not exceed minimum values by more than 20 degrees F.
    - c. Subject to acceptance of Architect, an accelerating admixture may be used. Admixtures shall meet the requirements of Part 2. Calcium chloride and other chloride-type accelerating admixtures shall not be allowed.
    - d. Do not place concrete on frozen subgrade. Frozen subgrade shall be thawed to minimum depth of 2 feet prior to concrete placement.
    - e. Minimum temperature of massive embedments at time of concrete placement shall be 32 degrees F.
    - f. Comply with concrete protection temperature requirements of ACI 306.1. Record concrete temperatures during specified protection period at intervals not to exceed 16 hours and no less than twice during any 24-hour period.
    - g. Submittal of detailed procedures, means, and methods for production, transportation, placement, protection, curing, and temperature monitoring of concrete during cold weather is not required.
  - 2) Hot Weather Placement:

- a. When depositing concrete in hot weather, follow recommendations of ACI 305R.
  - b. Temperature of concrete at time of placement shall not exceed 85 degrees F.
  - c. When air temperatures on day of placement are expected to exceed 85 degrees F., mix ingredients shall be cooled before mixing. Flake ice or well-crushed ice of a size that will melt completely during mixing may be substituted for all or part of mix water.
  - d. Retarding admixture may be used subject to acceptance of Architect. Admixtures shall meet requirements of Part 2.
  - e. Protect to prevent rapid drying. Start finishing and curing as soon as possible. Use of continuous fog sprays may be required by Architect for 24 hours after depositing or work may be restricted to evenings or nights, especially in times of low humidity.
- 3) Unless adequate protection is provided, concrete shall not be placed during rain, sleet, or snow. Rainwater shall not be allowed to increase the mixing water nor to damage the surface finish.
- B. Protection: Protect newly finished slabs from rain damage. Cover masonry walls, glazing, and other finish materials with polyethylene or otherwise protect from damage due to placing of slabs or sidewalks.

## **PART 2 PRODUCTS**

### **2.01 FORMWORK**

- A. Comply with requirements of Section 03 10 00.

### **2.02 REINFORCEMENT**

- A. Comply with requirements of Section 03 20 00.

### **2.03 CONCRETE MATERIALS**

- A. General: Ready-mixed Concrete: ASTM C94. On-site mixed concrete not allowed.
- B. Cement: ASTM C150, Type I/II Portland type may be used for all concrete.
  - 1) Acquire all cement for entire project from same source.
- C. Fine and Coarse Aggregates: ASTM C 33.
  - 1) Acquire all aggregates for entire project from same source.
    - a. Fine Aggregate: Natural sand.
    - b. Coarse Aggregate: Gravel or crushed stone containing no deleterious substances that cause surface spalling. Determine maximum coarse aggregate size by thickness of members, finish required, and spacing of reinforcement. Size: Accepted by Architect prior to placing any concrete.
- D. Fly Ash: ASTM C618, Class C or F. Fly ash as a substitute for cement will be allowed unless otherwise indicated. Fly ash shall not exceed 20% of total cementitious material by weight.
- E. Fibrous Reinforcing: ASTM C1116, Type III 4.1.3 and Performance Level 1, 15 toughness index.
  - 1) Type: Virgin polypropylene collated, fibrillated fibers containing no reprocessed olefin materials and having tensile strength of not less than 70,000 psi.
  - 2) Fiber Length: Per manufacturer's recommendation for placement application.
- F. Water: Potable.
- G. Certification: Submit written conformance to above-mentioned requirements and chloride ion content prior to mix design review by Architect.

## 2.04 ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. Water Reducing Admixture: ASTM C494/C494M Type A, containing not more chloride ions than present in municipal drinking water:
  - 1) Manufacturers:
    - a. Eagle Admixtures Conad N.
    - b. Euclid Eucon WR-75.
    - c. Master Builders Pozzolith 344N.
    - d. Gifford Hill PSI-N.
    - e. Sika Plastocrete 161.
    - f. Substitutions: See Section 01 60 00 - 01 60 00.
- D. Non-Corrosive, Non-Chloride Accelerator: ASTM C494, Type C or E, containing not more chloride ions than present in municipal drinking water and with long term test data from independent testing laboratory providing non-corrosive effect on reinforcing steel:
  - 1) Euclid Accelguard 80.
  - 2) W.R. Grace Darex Set Accelerator.
  - 3) Sika Plasocrete 161 FL.
  - 4) Master Builders Pozzutec 20.
  - 5) Gifford-Hill Gilco Accelerator.
  - 6) Substitutions: See Section 01 60 00 - 01 60 00.
- E. Calcium Chloride: Calcium chloride, thiocyanate, and admixtures containing more than 0.05% chloride ions not allowed.
- F. Certification: Submit written conformance to above-mentioned requirements and chloride ion content prior to mix design review by Architect.

## 2.05 ACCESSORY MATERIALS

### 2.06 BONDING AND JOINTING PRODUCTS

- A. Epoxy Adhesives for use in All Structural Repairs: Two component, 100% solids, 100% reactive compound suitable for use on dry or damp surfaces and comply with ASTM C881.
  - 1) Euclid Euco Epoxy 452MV or 620.
  - 2) Sika Sikadur Hi-Mod L.V. or Sikadur Hi-Mod.
  - 3) Substitutions: See Section 01 60 00 - 01 60 00.
  - 4) Where epoxy injection procedures are used, use low viscosity epoxy made by one of above manufacturers.
- B. Bonding Compound: Use only at areas not subject to moisture.
  - 1) Euclid Euco Weld.
  - 2) Larsen Products Weldcrete.
  - 3) Sika Sikabond.
  - 4) Substitutions: See Section 01 60 00 - 01 60 00.
- C. Waterstops: Polyvinyl chloride, minimum 1,750 psi tensile strength, minimum 50 degrees F to plus 175 degrees F working temperature range, 6" inch wide, maximum possible lengths, ribbed profile, preformed corner sections, heat welded jointing. Provide waterstop 609 retro-fit PVC manufactured by Greenstreak.
- D. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.

- 1) Material: ASTM D1751, cellulose fiber.
  - 2) Products: Basis-of-Design.
    - a. W.R. Meadows, Inc; Fiber Expansion Joint Filler with Snap-Cap.
    - b. Substitutions: See Section 01 60 00 - 01 60 00.
- E. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with minimum 1 inch diameter holes for conduit or rebars to pass through at 6 inches on center; ribbed steel stakes for setting.

## 2.07 CURING MATERIALS

- A. Miscellaneous Materials:
- 1) Curing Compound - Vertical Surfaces: ASTM C309 - latest edition.
  - 2) Curing Compound - Interior Slabs:
  - 3) Dayton Superior
    - a. Euclid Super Rex or Super Pliocure.
    - b. MasterBuilders
    - c. Sonneborn
    - d. Substitutions: See Specification 01 60 00 - 01 60 00.
- B. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
- 1) Manufacturers:
    - a. Dayton Superior Corporation; AquaFilm Concentrate J74: [www.daytonsuperior.com](http://www.daytonsuperior.com).
    - b. SpecChem, LLC; SpecFilm Concentrate or SpecFilm RTU: [www.specchemllc.com/sle](http://www.specchemllc.com/sle).
    - c. W.R. Meadows, Inc ; Evapre or Evapre-RTU: [www.wrmeadows.com/sle](http://www.wrmeadows.com/sle).
    - d. Substitutions: See Section 01 60 00 - 01 60 00.
- C. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.
- 1) Manufacturers:
    - a. Dayton Superior Corporation; Resin Cure with Dye J11WD.
    - b. Dayton Superior Corporation; Clear Resin Cure J11W.
    - c. Dayton Superior Corporation; Clear Cure VOC J7WB.
    - d. Kaufman Products Inc.; Thinfilm 420 Resin Base: [www.kaufmanproducts.net](http://www.kaufmanproducts.net).
    - e. SpecChem, LLC; SpecRez.
    - f. W.R. Meadows, Inc.; 1100-Clear.
    - g. Substitutions: See Section 01 60 00 - 01 60 00.
- D. Moisture-Retaining Sheet: ASTM C171.
- 1) Waterproof paper, regular.
  - 2) Polyethylene film, clear, minimum nominal thickness of 0.0040 inch.
  - 3) White-burlap-polyethylene sheet, weighing not less than 10 ounces per linear yard, 40 inches wide.

## 2.08 PROPORTIONING AND DESIGN OF MIXES

- A. Reference Standard: ACI 301 Section 4.
- B. Design: Conform to general notes on structural drawings. Proportion ingredients for mixes in accordance with ACI 301, 4.2.2 and 4.2.3.
- 1) Should Contractor require special mix due to structural requirements, weather or materials, submit samples of cement and aggregate to be used to approved



testing laboratory. Testing laboratory will make analysis of materials and design proper mix to be used.

- C. Slump: Design water-cementitious material ratio to provide slumps indicated under mix type.
  - 1) Concrete Placed by Pumping: Maximum slump of 4" at discharge end of hose.
- D. Water/Cementitious Material Ratio for All Concrete: 0.50, maximum unless specified otherwise under mix types.
- E. Selection of Proportions:
  - 1) Mix Design: Cost of concrete mix design by concrete contractor.
  - 2) Selection of Proportions: Use method of ACI 301 Section 4. Proportioning based on empirical data not allowed.
- F. Admixtures:
  - 1) General: No admixtures will be allowed except as specified herein unless authorized by the Architect. All requests for approval or substitution must be made by the General Contractor and be accompanied by sufficient information and test data for evaluation. All admixtures shall be chemically compatible with cementitious materials and all other admixtures used in the mix. All admixtures shall be chloride free. No calcium chloride shall be added to concrete.
- G. Chloride Ions: Maximum water-soluble chloride ion concentration in concrete mix shall not exceed following percentages by weight of cementitious materials.
  - 1) Concrete Over Metal Decks: 0.06%.
  - 2) Other Concrete: 0.15%.
- H. Mixing: Add aggregate and approximately two-thirds of required water to mixer first and mix minimum of 70 revolutions at mixing speed to insure wetting of all aggregate particles, then add cement, air entraining agent and remaining water and mix minimum of 30 revolutions of mixing speed.

## 2.09 CONCRETE MIX DESIGN

- A. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.
  - 1) Non-Corrosive, Non-Chloride Accelerator: Use at all concrete slabs placed at air temperature below 50 degrees F.
  - 2) Air Entraining Agent: Use at all concrete required to be air entrained.
- B. Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions.
- C. The following concrete mix types will be required:
  - 1) **Mix A** - For Footings, Foundations, and Foundation Extensions:
    - a. 4500 psi (water/cement Ratio: 0.50 maximum)
    - b. Type I/II Cement, Minimum of 540 Pounds per Cubic Yard
    - c. ¾" Maximum Aggregate Size
    - d. 6% +/- 1-1/2% Entrained Air
    - e. 4" Maximum Slump
  - 2) **Mix B** - For Interior Slabs on Grade, Slabs on Metal Deck, House-keeping Slabs:
    - a. 4000 psi (water/cement ratio: 0.42 maximum)
    - b. Type I/II Cement, Minimum of 540 Pounds per Cubic Yard
    - c. ¾" Maximum Aggregate Size
    - d. 0% - 3% Entrained Air
    - e. 4" Maximum Slump

- f. Water Reducing Agent: Use in accordance with manufacturer's recommendations.
- 3) **Mix C** - For Sidewalks and Exterior Concrete: See Section 32 13 13, "Concrete Paving", for Mix D design.

## **2.10 MIXING**

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Architect's Review: Provide minimum of 24 hour notice to Architect to allow him to review forms and reinforcement just before concrete is placed and to observe placing of concrete.
- B. Contractor's Review: Contractor shall inspect forms and reinforcing prior to concrete placement to assure accurate placement of embedded items.

### **3.02 GENERAL**

- A. Install concrete work in accordance with ACI 301 unless amended or superseded by this section or notes on structural drawings.

### **3.03 PREPARATION**

- A. Verify that forms are clean and free of rust before applying release agent.
- B. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- C. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by roughing up surface, cleaning with steel brush, and applying bonding agent in accordance with manufacturer's instructions.
- D. Protection: Cover walls, glazing, and other finish materials with polyethylene or otherwise protect from damage due to placing of slabs, sidewalks or floors above.

### **3.04 PLACING CONCRETE**

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Ensure reinforcement and waterstops will not be disturbed during concrete placement.
- D. Placement: Place concrete in approximately uniform horizontal layers not over two feet in height. Piling up of concrete in forms or cutting in manner to separate aggregates will not be permitted. Do not drop concrete in free fall over 5 feet.
- E. Water: Prevent accumulations of water on surface of concrete due to water gain, segregation, or other causes, during placement or compacting. Make provision for removal of water as may accumulate so that concrete not be placed in such accumulation.
- F. Consolidation: Consolidate concrete during and immediately after depositing by means of mechanical vibrators. Supplement the consolidation by hand spading at corners and angles of forms, around embedded fixtures and in other difficult areas.
  - 1) Mechanical Vibrator: Comply with ACI 309, with minimum frequency of 10,000 cycles per minute.
  - 2) Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of

concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

- G. Finishing:
  - 1) Where tops of cast-in-place concrete walls will form finished surface, immediately finish concrete in form by skilled cement finisher. Walls or surfaces not finished to level subject to removal and replacement.
- H. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

### **3.05 FLATWORK**

- A. Screeds: Establish finish plane of horizontal surfaces by screeds, carefully aligned and securely set, spaced not over eight feet apart and installed at proper level or slope, prior to placing concrete.
- B. Floor Slab Tolerances: Level within maximum tolerance of 1/4" in 10 feet except slope to drains. Comply with structure tolerance requirements of floor finish manufacturers where applicable.
- C. Selection of Finishes: In accordance with ACI 301 5.3.4 unless otherwise indicated. Finish surfaces sparingly with special tools, such as roller bugs, to force coarse aggregate slightly below surface. Jitterbug tampers not allowed without acceptance of Architect. Dusting of wearing surfaces with dry materials not allowed. Steel or magnesium trowels and floats shall be used for finishing interior slabs containing fibrous reinforcing.
- D. Requirements for Slab Finish: Comply with requirements of various Sections for slab tolerances, finishes, curing, etc. Be responsible to repair or replace slabs as required and specified in those sections to meet requirements.
  - 1) Exterior Slabs: Installed under Section 32 13 13.

### **3.06 SLAB JOINTING**

- A. Locate joints as indicated on the drawings.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
- D. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.

### **3.07 FLOOR FLATNESS AND LEVELNESS TOLERANCES**

- A. Maximum Variation of Surface Flatness:
  - 1) Exposed Concrete Floors: 1/4 inch in 10 feet.
  - 2) Under Seamless Resilient Flooring: 1/4 inch in 10 feet.
  - 3) Under Carpeting: 1/4 inch in 10 feet.
- B. Correct the slab surface if tolerances are less than specified.
- C. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

### **3.08 CONCRETE FINISHING**

- A. Repair surface defects, immediately after removing formwork.

- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
- C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
  - 1) Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.
- D. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:

### 3.09 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Protection: Protect exposed surfaces of concrete from premature drying and frost. Protect freshly placed concrete from rain damage. Protect finished slabs from mortar leakage from pouring of slabs above.
- D. Form Removal: Do not remove forms until times as specified. Remove carefully to not injure concrete surface. Protect edges and corners to prevent cracking, chipping or other damage and premature drying.
- E. Vertical Surfaces: Clean surfaces of loose sand, mortar, debris and grout; spray lightly with water and coat with clear or translucent curing compound as soon as possible after removing forms. Apply curing compound same working day that forms are removed.
- F. Surfaces Not in Contact with Forms:
  - 1) As soon as possible after placing concrete, coat exposed horizontal surfaces with curing compound in accordance with manufacturer's recommendations and cover with white polyethylene sheeting of minimum of six mil nominal thickness. Give special attention to providing adequate curing of slab edges.
  - 2) Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
  - 3) Final Curing: Begin after initial curing but before surface is dry.
    - a. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.
  - 4) Provide polyethylene sheeting as wide as practical, edges lapped minimum of six inches, weighted to prevent blowing, and sealed to prevent loss of moisture. Keep sheeting in place a minimum of seven days.

### 3.10 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Test Priority: Control tests shall be used to determine concrete quality throughout project; however, special tests shall have precedence over control tests, and core tests shall have precedence over all previous tests.
- D. Tests: Cooperate fully with those making tests. Following tests and procedures are subject to change during construction at discretion of Architect:

- 1) Test Reports: In accordance with Section 01 40 00, "Quality Requirements".
  - 2) Slump Tests: The General Contractor shall provide necessary equipment and shall make tests in conformity with ASTM C143-03. The Contractor shall make slump tests on the first truck of each pour and as often as deemed necessary by the Contractor to maintain the required slump and adequate records. In addition the Contractor shall make slump tests when directed by the Architect.
    - a. Tests shall be made by a person thoroughly familiar with requirements specified.
    - b. Sample concrete at point of placement.
    - c. Should slump exceed limits stated in Concrete Mix Types in Part 2, batch shall be rejected.
    - d. Keep accurate record of time, location in work and results of slump tests that shall be available for inspection by Owner and Architect.
  - 3) Control Tests:
    - a. Control tests of concrete work shall be made on every 50 cubic yards or fraction thereof of concrete placed and, in any case, minimum of once during each day's pour.
    - b. Each test shall consist of six standard 6" test cylinders cast and cured in accordance with ASTM C31 and ASTM C172.
    - c. Sample concrete at point of placement.
    - d. Two cylinders shall be broken at end of seven days after placing, two cylinders shall be broken at end of 28 days after placing, and remaining cylinders shall be stored until their disposition is determined by Architect.
    - e. In general, remaining cylinders will be broken only when previous test reports indicated unsatisfactory results.
    - f. Test on remaining cylinders shall be at expense of the Contractor.
    - g. Architect reserves right to stop future concrete work when seven or 28 day tests indicate unsatisfactory results until, in his opinion, proper corrective measures have been taken to insure quality concrete in future work and corrections deemed necessary have been made.
    - h. Tests shall be made at time control tests are taken and so stated in reports to determine slump, air content, unit weight and temperature of concrete.
- E. All tests shall be made in accordance with ASTM C138 or ASTM C231.
- 1) Special Tests:
    - a. Should Contractor desire control tests to facilitate early removal of forms, they shall be made in addition to those specified for control tests and shall be completely site-cured.
    - b. Expense for making additional test cylinders, testing, curing and protection shall be Contractor's.
  - 2) Strength Level: Considered satisfactory if average of all three sets of consecutive strength test results equal or exceed specified strength and no individual strength test result falls below specified strength by more than 500 psi.
  - 3) Core Tests:
    - a. If, at any time, concrete control test specimens show compressive strength of 28 days below required level, or if concrete has been frozen before it has taken final set, so severely that in opinion of Architect, its strength has been adversely affected, Contractor shall, at his own expense, have sufficient core test taken, number and location to be accepted by Architect on such portions of work as may have been affected to determine actual conditions of concrete.

- b. Securing, Preparing and Testing: ASTM C42. Should tests reveal that concrete does not meet requirements of this specification, Contractor shall, at his own expense, replace entire section involved or make corrections deemed necessary by Architect.
  - 4) Special Inspection: Special Inspection of Structural Concrete Construction shall be performed in accordance with the Statement of Special Inspections as submitted to the Building Official. This inspection shall be performed by an approved special inspector selected and paid for by the Owner.
- F. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

### 3.11 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- C. Repair:
  - 1) Modify or replace concrete not conforming to required lines, details, and elevations.
  - 2) Repair or replace concrete not properly placed resulting in excessive honeycombing and other defects. Do not patch, repair or replace exposed architectural finished concrete except upon express direction of Architect.
  - 3) Patch holes and defects.
- D. Repair defects in structural concrete walls as follows:
  - 1) Deep Defects Exposing Reinforcing: Chip to sound concrete and clean thoroughly to remove loose concrete and dust. Apply thick coat of epoxy adhesive. Form and pour full with non-shrink grout prior to development of tack-free condition of epoxy adhesive. Strip forms after grout has hardened and provide specified finish. Moist cure and apply clear curing and sealing compound immediately after finishing.
  - 2) Defects Greater Than 1/2-Inch Depth Not Exposing Reinforcing: Chip, clean, and apply epoxy adhesive. Place or dry pack using non-shrink grout prior to development of tack-free condition of epoxy adhesive. If dry pack consistency is required, use non-shrink grout damp pack formula. Provide specified finish and cure.
  - 3) Defects Less Than 1/2 Inch Depth and All Tie Holes:
    - a. For concrete having a specified compressive strength of 5,000 psi or less: Chip and clean per 1. above. Dry pack, finish and cure per 1. above.
  - 4) Other equivalent repair procedures may be used subject to review of Architect.
- E. Unformed Surfaces:
  - 1) Test unformed surfaces such as monolithic slabs for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope in addition to smoothness using a template having required slope.
  - 2) Correct high areas in unformed surfaces by grinding or other methods acceptable to the Architect after concrete has cured a min. of 14 days.
  - 3) Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend with adjacent concrete. Where acceptable to the Architect, the specified underlayment compound applied in accordance with the manufacturer's instructions may be used.

- 4) Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean square cuts, and expose reinforcing steel with at least ¾" patching concrete, and apply specific bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- 5) Repair isolated random cracks and single holes not over 1" in diameter by dry pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned surfaces and apply specified bonding compound. Mix dry pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact dry pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

### **3.12 PROTECTION**

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.
- B. Protect newly finished slabs from weather damage.

**END OF SECTION**





## **SECTION 05 05 13**

### **SHOP-APPLIED METAL FINISHES**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Shop-applied PVDF finishes for steel pipe bollards and railings.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 30 00 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.
- B. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Section 01 78 00 - Closeout Submittals: Project record documents, operation and maintenance (O&M) data, warranties and bonds.
- D. Section 05 50 00 - Metal Fabrications: Pipe bollards.
- E. Section 05 52 13 - Pipe and Tube Railings: Steel pipe railings.

##### **1.03 REFERENCE STANDARDS**

- A. American Architectural Manufacturers Association (AAMA).
  - 1) 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Architectural Extrusions and Panels.
- B. ASTM - D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
- C. ASTM - D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.

##### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Color Schedule: The Architect will provide a color schedule to the Contractor after a paint manufacturer is selected and color chips have been submitted.
- C. Product Data: Provide complete list of products to be used, with the following information for each:
  - 1) Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
  - 2) Cross-reference to specified paint system(s) product is to be used in; include description of each system.
  - 3) Manufacturer's installation instructions.
- D. Samples: Submit two painted samples, illustrating selected colors for each color and system selected. Submit on paint suppliers standard sample material, 8" by 10" inch in size.
- E. Certification:
  - 1) By manufacturer that paints and finishes comply with VOC limits specified.
  - 2) Certificates of Compliance: Manufacturer's certification that finishes applied on Project components comply with referenced AAMA standards.
- F. Manufacturer's Instructions: Indicate special surface preparation procedures.
- G. Maintenance Materials: Furnish the following for the Owner's use in maintenance of the project.
  - 1) See Section 01 60 00 - 01 60 00, for additional provisions.
  - 2) Extra Paint and Finish Materials: 1 gallon of each color and type; from the same product run,.

- 3) Label each container with color and color number or formula for each type in addition to the manufacturer's label.

### **1.05 QUALITY ASSURANCE**

- A. Applicator Qualifications: Company specializing in performing painting on projects with the same type of material and extent of work as indicated for this project, and approved by manufacturer.
- B. Single-Source Responsibility: Provide primers and undercoat material produced by the same manufacturer as the finish coats for each type of coating. Use only thinners recommended by the manufacturer and only within recommended limits.
- C. Comply with EPA guidelines regarding paints formulated with any of the following ingredients, in any amount:
  - 1) Red lead.
  - 2) Basic lead silico chromate.
  - 3) Zinc chromate.
  - 4) Lead driers.

### **1.06 MATERIAL QUALITY**

- A. All products not specified by name shall be "best grade" or "first line" products of acceptable manufacturers. See Part 3 Execution for materials required for this project. Where possible, materials shall be of a single manufacturer. Paint material containers not displaying manufacturer's product identification will not be acceptable.
- B. Proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude equal products of other manufacturers.

### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Apply manufacturer's standard protective coverings to finished surfaces.
- B. Deliver, store, and handle finished components in manner to prevent damage to finishes.
- C. Furnish touch-up paint along with each material shipment.

### **1.08 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Furnish manufacturer's 10year warranty providing coverage that coatings:
  - 1) Will not chip, crack or peel (lose adhesion) but this does not include minute fracturing which may occur in proper fabrication of building parts.
  - 2) Will not chalk in excess of ASTM D4214 Number 8 rating, determined by procedure outlines in ASTM D4214.
  - 3) Will not change color more than five Delta-E Hunter units (square root of the sum of square Delta L, Delta a, and Delta b) as determined by ASTM D2244, Method 6.3. Fading or color changes may not be uniform if surfaces are not equally exposed to sun and elements. Mica and metallic coatings are exempt due to inability to accurately measure color; mica and metallic flakes reflect and scatter light in random patterns.
- C. Furnish manufacturer's 5 year warranty providing coverage that coatings:
  - 1) Will not chip, crack or peel (lose adhesion) but this does not include minute fracturing which may occur in proper fabrication of building parts.
  - 2) Will not chalk in excess of ASTM D4214 Number 8 rating, determined by procedure outlines in ASTM D4214.
  - 3) Will not change color more than five Delta-E Hunter units (square root of the sum of square Delta L, Delta a, and Delta b) as determined by ASTM D2244, Method

6.3. Fading or color changes may not be uniform if surfaces are not equally exposed to sun and elements. Mica and metallic coatings are exempt due to inability to accurately measure color; mica and metallic flakes reflect and scatter light in random patterns.

- D. Furnish applicator's 5 year warranty providing coverage against failure of PVDF-based coating over improper pretreatment where coating was not applied in accordance with ASTM D1730, Type B, Method 5 or ASTM B449, Section 5.

## **PART 2 PRODUCTS**

### **2.01 APPLICATORS**

- A. Linetec.
- B. Substitutions: See Section 01 60 00 - 01 60 00.

### **2.02 SHOP APPLIED FINISHES**

- A. PVDF-Based Coating: AAMA 2604, fluoropolymer finish containing minimum 50 percent PVDF resins, two coat system. Color to be RAL 6009 - Dark Green.

## **PART 3 EXECUTION**

### **3.01 ADJUSTING**

- A. Touch up minor scratches and abrasions in finishes in accordance with finish manufacturer's instructions; replace components having damage that cannot be successfully touched up.

### **3.02 CLEANING**

- A. Clean finished surfaces after installation in accordance with finish manufacturer's instructions.

### **3.03 CLOSEOUT ACTIVITIES**

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

## **END OF SECTION**



## **SECTION 05 50 00 METAL FABRICATIONS**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Shop fabricated steel items.
  - 1) Loose steel lintels.
  - 2) Steel framing and supports including the following:
    - a. Applications where framing and supports are not specified in other sections.
    - b. Tube steel framing for utility yard enclosure.
  - 3) Sheet metal blocking.
  - 4) Pipe bollards.
  - 5) Uni-strut support system.
  - 6) All other miscellaneous angles, channels, tubes and plates as indicated and required.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 05 05 13 - Shop-Applied Metal Finishes. Powder coating of exterior railings.
- B. Section 05 52 13 - Pipe and Tube Railings.
- C. Section 09 21 16 - Gypsum Board Assemblies: Placement of backing plates in stud wall construction.
- D. Section 09 91 13 - Exterior Painting: Paint finish.
- E. Section 09 91 23 - Interior Painting: Paint finish.

#### **1.03 REFERENCE STANDARDS**

- A. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015.
- B. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); 2002 (Ed. 2004).

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product data for each material specified.
- C. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
  - 1) Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

#### **1.05 PROJECT CONDITIONS**

- A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.
  - 1) Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. General: Comply with Section 01 60 00, "Product Requirements".

- 1) Store metals above ground on platforms, skids, or other supports. Protect steel from corrosion.
- 2) Store other materials in weathertight and dry place, until ready for use.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS - STEEL**

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing. Tube steel for utility yard enclosure.
- C. Plates: ASTM A283/A283M.
- D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.
- E. Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1, plain.
- F. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- G. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

### **2.02 FABRICATION**

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

### **2.03 FABRICATED ITEMS**

- A. Sheet Metal Blocking:
  - 1) Provide 8 ga. by 12" wide sheet metal blocking for wall mounted products full length of product. Screw sheet metal blocking at each stud along length of run with three (3) screws per stud.
- B. Steel Tube:
  - 1) 16 GA steel formed in half round configuration. See contract drawings for size.
  - 2) Prime paint steel to be field painted.
- C. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; powder coat finish per Section 05 05 13, Shop-Applied Metal Finishes. Construct from 80 ga. steel pipe. See contract drawings for size.
- D. Lintels: As detailed; prime paint finish.
- E. Uni-strut Support System
  - 1) General: Fabricate from cold-formed, low-carbon strip steel.
    - a. Gauge: 12 ga.
    - b. Size: 1 5/8" unless indicated otherwise.

### **2.04 FINISHES - STEEL**

- A. Prime paint steel items.
- B. Prepare surfaces to be primed in accordance with SSPC surface preparation.
  - 1) Exteriors (SSPC Zone 1B): SSPC-SP6/NACE No. 3, "Commercial Blast Cleaning."
  - 2) Interiors (SSPC Zone 1A): SSPC-SP3 "Power Tool Cleaning."
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

D. Prime Painting: One coat.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

A. Verify that field conditions are acceptable and are ready to receive work.

#### **3.02 PREPARATION**

A. Clean and strip primed steel items to bare metal where site welding is required.

#### **3.03 INSTALLATION**

A. Install items plumb and level, accurately fitted, free from distortion or defects per approved shop drawings.

B. Field weld components as indicated on drawings.

C. Perform field welding in accordance with AWS D1.1/D1.1M.

D. After erection, grind and prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

### **3.04 TOLERANCES**

- A. Maximum Variation From Plumb: 3/16" inch.



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

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Wall mounted handrails.
- B. Stair railings and guardrails.
- C. Free-standing railings at ramp and steps.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 05 05 13 - Shop-Applied Metal Finishes. Powder coating of exterior railings.
- B. Section 09 91 23 - Interior Painting: Paint finish. Interior railings.
- C. Section 32 13 13 - Concrete Paving: Placement of anchors in concrete.

#### **1.03 REFERENCE STANDARDS**

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- C. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 1999 (Ed. 2004).

#### **1.04 PERFORMANCE REQUIREMENTS**

- A. Structural Performance of Handrails and Railing Systems: Engineer, fabricate, and install handrails and railing systems to withstand the following structural loads without exceeding the allowable design working stress of the materials for handrails, railing systems, anchors, and connections. Apply each load to produce the maximum stress in each of the respective components comprising handrails and railing systems.
  - 1) Top Rail of Guardrail Systems: Capable of withstanding the following loads applied as indicated:
    - a. Concentrated load of 200 lbf applied at any point and in any direction.
    - b. Uniform load of 50 lbf per linear foot applied horizontally and concurrently with uniform load of 100 lbf per linear foot applied vertically downward.
    - c. Concentrated and uniform loads above need not be assumed to act concurrently.
  - 2) Handrails Not Serving as Top Rails: Capable of withstanding the following loads applied as indicated:
    - a. Concentrated load of 200 lbf applied at any point and in any direction.
    - b. Uniform load of 50 lbf per linear foot applied in any direction.
    - c. Concentrated and uniform loads above need not be assumed to act concurrently.
  - 3) Infill Area of Guardrail Systems: Capable of withstanding a horizontal concentrated load of 200 lbf applied to one (1) sq. ft. at any point in the system including panels, intermediate rails, balusters, or other elements composing the infill area.
    - a. Above load need not be assumed to act concurrently with loads on top rails of railing systems in determining stress on guard.
- B. Thermal Movements: Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in engineering, fabricating, and installing handrails and railing systems to prevent buckling, opening of joints, overstressing of components and connections, and other detrimental effects. Base

engineering calculation on actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

1) Exterior Temperature Change (Range): 120 deg F ambient, 180 deg F material surfaces.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

### **1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

### **1.06 PROJECT CONDITIONS**

- A. Field Measurements: Where handrails and railing systems are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Handrails and Railings:
  - 1) The Wagner Companies:
  - 2) Local shops that comply with requirements.

### **2.02 RAILINGS - GENERAL REQUIREMENTS**

- A. Dimensions: See drawings for configurations and heights.
  - 1) Top Rails and Wall Rails: 1-1/2 inches diameter, round.
  - 2) Intermediate Rails: 1-1/2 inches diameter, round.
  - 3) Intermediate Rails: 3/4" inches diameter, round. Vertical pickets.
  - 4) Posts: 1-1/2 inches diameter, round.
- B. Provide anchors and other components as required to install posts to concrete, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
- C. Provide slip-on non-weld mechanical fittings to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.

### **2.03 STEEL RAILING SYSTEM**

- A. Steel Pipe: ASTM A53/A53M, Grade A Schedule 40, black finish.
- B. Welding Fittings: Factory- or shop-welded from matching pipe; seams continuously welded; joints and seams ground smooth.
- C. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

### **2.04 FABRICATION**

- A. Accurately form components to suit specific project conditions and for proper connection to building structure.
- B. Fit and shop assemble components in largest practical sizes for delivery to site.
- C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.

D. Welded Joints:

- 1) Exterior Components: Continuously seal joined pieces by intermittent welds and plastic filler. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
- 2) Interior Components: Continuously seal joined pieces by intermittent welds and plastic filler.
- 3) Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

- A. Verify that field conditions are acceptable and are ready to receive work.

**3.02 PREPARATION**

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be cast into concrete with setting templates, for installation as work of other sections.

**3.03 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.
- C. Install railings in compliance with ADA Standards for accessible design at applicable locations.
- D. Anchor railings securely to concrete.

**3.04 TOLERANCES**

- A. Maximum Variation From Plumb: 1/4 inch per floor level, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

**END OF SECTION**



## **SECTION 06 10 00 ROUGH CARPENTRY**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Sheathing.
- B. Preservative treated wood materials.
- C. Fire retardant treated wood materials.
- D. Concealed wood blocking, nailers, and supports.
- E. Miscellaneous wood nailers, furring, and grounds.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 07 25 00 - Weather Barriers: Water-resistive barrier over sheathing.
- C. Section 08 71 00 - Hardware: Blocking for hardware.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- B. ASTM D2898 - Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 2010.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- D. AWPA U1 - Use Category System: User Specification for Treated Wood; 2012.
- E. PS 1 - Structural Plywood; 2009.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials and application instructions.

#### **1.05 QUALITY ASSURANCE**

- A. Single-Source Responsibility for Fire-Retardant-Treated Wood: Obtain each type of fire-retardant-treated wood product from one source and by a single producer.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
  - 1) Fire-Retardant-Treated Materials, Interior Type A:
    - a. Baxter: J. H. Baxter Co.

- b. Chemical Specialties, Inc.
- c. Continental Wood Preservers, Inc.
- d. Hickson Corp.
- e. Hoover Treated Wood Products, Inc.
- f. Substitution: See Section 01 60 00 - 01 60 00

## **2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS**

- A. Sizes: Nominal sizes as indicated on drawings, S4S.
- B. Moisture Content: S-dry or MC19.
- C. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
  - 1) Lumber: S4S, No. 2 or Standard Grade.
  - 2) Boards: Standard or No. 3.

## **2.03 CONSTRUCTION PANELS**

- A. Wall Sheathing: Plywood, PS 1, Grade C-C, Exterior Exposure.

## **2.04 ACCESSORIES**

- A. Fasteners and Anchors:
  - 1) Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
  - 2) Power-Driven Fasteners: CABO NER-272.
  - 3) Wood Screws: ASME B18.6.1.
  - 4) Lag Bolts: ASME B18.2.1.
  - 5) Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

## **2.05 FACTORY WOOD TREATMENT**

- A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
  - 1) Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
- B. Fire Retardant Treatment:
  - 1) Exterior Type: AWPA U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
    - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
    - b. Treat exposed exterior rough carpentry items, including stairways, balconies, and covered walkways
    - c. Do not use treated wood in direct contact with the ground.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION - GENERAL**

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

### **3.02 BLOCKING, NAILERS, AND SUPPORTS**

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- C. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- D. Provide the following specific non-structural framing and blocking:
  - 1) Cabinets and shelf supports.
  - 2) Wall brackets.
  - 3) Handrails.
  - 4) Grab bars.
  - 5) Towel and bath accessories.
  - 6) Wall-mounted door stops.
  - 7) Where indicated on Contract Drawings.

### **3.03 INSTALLATION OF CONSTRUCTION PANELS**

- A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using nails, screws, or staples.

**END OF SECTION**





**SECTION 06 82 00**  
**GLASS FIBER REINFORCED PLASTIC**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Glass fiber reinforced, resin fabrications.

**1.02 RELATED REQUIREMENTS**

- A. Section 07 92 00 - Joint Sealants: Sealant around perimeter.
- B. Section 09 21 16 - Gypsum Board Assemblies: Gypsum board walls.

**1.03 REFERENCE STANDARDS**

- A. ASTM Standards D3273 and D3274, resistance to mold and mildew.
- B. Surface-Burning Characteristics: Class A flame spread of less than 25, smoke developed less than 450 per ASTM E-84 latest version.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified component products.
- C. Samples: Submit manufacturer's full range of standard colors, textures, and patterns for Architects selection.

**1.05 QUALITY ASSURANCE**

- A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.
- B. Meets USDA/FSIS requirements.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Protect components from damage by retaining shipping protection in place until installation.

**1.07 FIELD CONDITIONS**

- A. Do not install site fabricated components when site conditions may be detrimental to successful installation.
- B. Maintain temperature and humidity conditions favorable to proper curing of resin during and after installation.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A. Fiberglass Reinforced Plastic (FRP) Manufacturer's:
  - 1) Marlite
  - 2) Nudo Products, Inc.
  - 3) Substitutions: See Section 01 60 00 - 01 60 00.
- B. The product listed below is for basis-of-design.
  - 1) Kemlite, Fire-X Glasbord, Fiberglass Panels with Surfaseal Surface Protection.
  - 2) Color / Texture: As selected by Architect from Manufacturer's full range of colors, textures, and patterns.
  - 3) Size: Four (4) foot wide by required height as indicated on Contract Drawings. (No horizontal joints will be allowed)
  - 4) Moldings: Provide PVC (polyvinyl chloride) moldings. Pre-molded one piece interior and exterior corners. Color to match panel color.

- 5) Wall Panels: Finish and thickness: Embossed 0.09 inch Fire-X Glasbord with Surfaseal.
- 6) Adhesive: Provide panel adhesive as recommended by panel manufacturer.

## **2.02 ACCESSORIES**

- A. Trim Accessories: Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, pre-molded one piece inside and outside corners, and caps as needed to conceal all edges. Color to match panel color.
- B. Adhesive: As recommended by plastic paneling manufacturer.
- C. Sealant: See specification section 07 92 00 for types of acceptable sealants.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions and product carton instructions for installation.
- B. Site Verification of Conditions: Verify that substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.
  - 1) Examine backup surfaces to determine that corners are plumb and straight, surfaces are smooth, uniform, clean and free from foreign matter, joints and cracks are filled flush and smooth with the adjoining surface.
  - 2) Do not begin installation until backup surfaces are in satisfactory condition.
  - 3) Report unsatisfactory conditions to the General Contractor in writing with a copy to the Architect.

### **3.02 PREPARATION**

- A. Surface Preparation: Prepare backup wall surface for application of panels per manufacturer's recommendations.
- B. Remove materials that might interfere with adhesive bond and prepare substrate per manufacturer's instructions.
- C. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
- D. Clean substrates of substances that could impair bond of adhesive, including oil, grease, dirt, and dust.
- E. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.

### **3.03 INSTALLATION**

- A. Fiberglass Reinforced Panel (FRP) Installation:
  - 1) Cut panels with carbide tipped saw blades or with snips when required.
  - 2) Install panels in a full spread of adhesive. For trowel type and application of adhesive, follow adhesive manufacturer's recommendations.
  - 3) Apply sealant to trim accessories before installing.
  - 4) Use products acceptable to panel manufacturer and install FRP system in accordance with panel manufacturer's printed instructions. Comply with panel manufacturer's Installation Guide.
  - 5) Install sealant at edges of all accessories to form a concave seal. See Contract Drawings for sealant locations.

### **3.04 CLEANING**

- A. Cleaning: Remove temporary coverings and protection of adjacent work areas.
  - 1) Repair or replace products that have been installed and are damaged.
  - 2) Clean installed products in accordance with manufacturer's instructions prior to Substantial Completion.
  - 3) Remove construction debris from project site and legally dispose of debris.
- B. Remove any adhesive or excessive sealant from panel face using solvent or cleaner recommended by panel manufacturer.

**END OF SECTION**



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

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Batt insulation and vapor retarder in exterior wall construction.
- B. Batt insulation for acoustical purposes.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 07 21 29 - Sprayed Insulation: Sprayed-on, adhered fibrous insulation.
- B. Section 07 25 00 - Weather Barriers: Separate air barrier and vapor retarder materials.
- C. Section 07 84 00 - Firestopping: Insulation as part of fire-rated through-penetration assemblies.
- D. Section 09 21 16 - Gypsum Board Assemblies: Batt insulation installed between metal stud framing.
- E. Section 09 21 16 - Gypsum Board Assemblies: Acoustic insulation inside walls and partitions.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2012.
- B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2014.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- D. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace At 750 Degrees C; 2012.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

#### **1.05 QUALITY ASSURANCE**

- A. Single-Source Responsibility for Insulation Products: Obtain each type of building insulation from a single source with resources to provide products complying with requirements indicated without delaying the Work.
- B. Fire-Test-Response Characteristics: Provide insulation and isolation materials and related materials with the fire-test-response characteristics specified elsewhere in this Section as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
  - 1) Surface-Burning Characteristics: ASTM E 84.
  - 2) Fire-Resistance Ratings: ASTM E 119.

## 1.06 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

## PART 2 PRODUCTS

### 2.01 INSULATING MATERIALS

- A. General: Provide insulating materials that comply with requirements and with referenced standards.
  - 1) Preformed Units: Sizes to fit applications indicated; selected from manufacturer's standard thicknesses, widths, and lengths.

### 2.02 BATT INSULATION MATERIALS

- A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used, at Contractor's option.
- B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
  - 1) Type: Type III, Class A.
  - 2) Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
  - 3) Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
  - 4) Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
  - 5) Thermal Resistance: R-value as indicated on the contract drawings.
  - 6) Facing: Aluminum foil, flame spread 25 rated; one side.
  - 7) Exposed Insulation: Insulation not installed substantially against the inside face of finish materials shall not have combustible coverings. Exposed insulation shall be foil faced with flame spread rating of 25 or less in accordance with ASTM E84-84.
  - 8) Manufacturers:
    - a. CertainTeed Corporation.
    - b. Johns Manville Corporation.
    - c. Owens Corning Corporation.
  - 9) Substitutions: See Section 01 60 00 - 01 60 00.
- C. Mineral Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.
  - 1) Application: Use for sound isolation batts.
  - 2) Facing: Non-faced.
  - 3) Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
  - 4) Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
  - 5) Thickness: As required per inch to meet required STC rating unless otherwise noted.
  - 6) Manufacturers:
    - a. Certain Teed Corporation.
    - b. Johns Manville International, Inc.; MinWool Sound Attenuation Fire Batts.
    - c. Owens Corning Corporation.
    - d. Thermafiber, Inc.
    - e. Substitutions: See Section 01 60 00 - 01 60 00.

### 2.03 ACCESSORIES

- A. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inch wide.
- B. Tape joints of rigid insulation in accordance with insulation manufacturers' instructions.

- C. Insulation Fasteners: Impaling clip of galvanized steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place. To be used for batt insulation where framing is not available for friction fit or as indicated on Contract Drawings.
- D. Adhesive: Type recommended by insulation manufacturer for application.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, or irregularities.

#### **3.02 PREPARATION**

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

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

- A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.
- B. Install insulation that is undamaged, dry, unsoiled, and has not been exposed at any time to ice and snow.
- C. Extend insulation in thickness or R-value indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

#### **3.04 BATT INSTALLATION**

- A. Install insulation in accordance with manufacturer's instructions.
- B. Install in exterior wall spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- E. Install with factory applied vapor retarder membrane facing warm side of building spaces. Lap ends and side flanges of membrane over framing members.
- F. Tape insulation batts in place.
- G. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.
- H. At metal framing, place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over member face.
- I. Tape seal tears or cuts in vapor retarder.

#### **3.05 INSTALLATION OF SOUND ISOLATION**

- A. Place in partitions tight within spaces, around cut openings, behind and around electrical and mechanical items within partitions and tight to items passing through partitions. Ductwork Penetrations: Provide one-inch-wide clearance around ductwork and pack with fiberglass ready for caulking.

### **3.06 PROTECTION**

- A. Do not permit installed insulation to be damaged prior to its concealment.

**END OF SECTION**



## **SECTION 07 21 29 SPRAYED INSULATION**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Closed-cell Spray Polyurethane Foam.
- B. Thermal Barrier.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- B. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials
- C. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace At 750 Degrees C; 2012.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on materials, describing insulation properties.
- C. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

#### **1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years of experience.
- C. Products Specified by Flammability or Combustibility Criteria: Listed and classified by Underwriters Laboratories Inc.

#### **1.06 FIELD CONDITIONS**

- A. Maintain acceptable ambient and substrate surface temperatures prior to, during, and after installation of insulation materials and sealer.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Glass Fiber:
  - 1) CertainTeed Corporation.
  - 2) Johns Manville,
  - 3) Substitutions: See Section 01 60 00 - 01 60 00.

#### **2.02 MATERIALS**

- A. Closed-cell Spray Polyurethane Foam.
  - 1) Density: 2.0 lb/cu ft.
  - 2) Closed cell content: 90% with ASTM D6226.
  - 3) Water Absorption: 0.88% with ASTM D2842.
  - 4) Combustibility: Passing ASTM E136.

- 5) Flame Spread and Smoke Developed Index: 10/0, when tested in accordance with ASTM E84.

### **2.03 ACCESSORIES**

- A. Thermal Barrier:
  - 1) Material: Fiber type.
  - 2) Rating: 15-minute thermal barrier.
  - 3) Application: Spray applied.
  - 4) Reference Standards:
    - a. ASTM E119.
    - b. NFPA 286.
  - 5) Manufacturers:
    - a. International Cellulose Corporation: Ure-k spray coating.
    - b. International Fireproof Technology Inc.: DC315 Polyurethane Foam (SPF)
    - c. Substitutions: See Section 01 60 00 - 01 60 00.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that surfaces are clean, dry, and free of matter that may inhibit adhesion.
- B. Verify other work on and within spaces to be insulated is complete prior to application.

### **3.02 PREPARATION**

- A. Mask and protect adjacent surfaces from overspray or damage.
- B. Apply primer in accordance with manufacturer's instructions.

### **3.03 INSTALLATION**

- A. Install insulation in accordance with manufacturer's instructions.
- B. Install insulation to a uniform monolithic density without voids.
- C. Install to achieve a thermal resistance as noted on contract drawings.
- D. Apply sealer in uniform coat at rate recommended by manufacturer.

### **3.04 PROTECTION**

- A. Do not permit subsequent construction work to disturb applied insulation.

**END OF SECTION**

## **SECTION 07 25 00 WEATHER BARRIERS**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Water-Resistive Barrier: Under exterior wall cladding, over sheathing or other substrate; not air tight or vapor retardant.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 06 10 00 - Rough Carpentry: Water-resistive barrier under exterior cladding.

#### **1.03 DEFINITIONS**

- A. Weather Barrier: Assemblies that form either water-resistive barriers, air barriers, or vapor retarders.
- B. Water-Resistive Barrier: Water-shedding barrier made of material that is moisture resistant, to the degree specified, intended to be installed to shed water without sealed seams.

#### **1.04 REFERENCE STANDARDS**

- A. ASTM E2357 - Standard Test Method for Determining Air Leakage of Air Barrier.
- B. ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers; ICC Evaluation Service, Inc; 2013.

#### **1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on material characteristics.

#### **1.06 FIELD CONDITIONS**

- A. Maintain temperature and humidity recommended by the materials manufacturers before, during and after installation.

### **PART 2 PRODUCTS**

#### **2.01 WEATHER BARRIER ASSEMBLIES**

- A. Water-Resistive Barrier: Provide on exterior walls under exterior cladding.
  - 1) Under Portland cement stucco, use two separate layers of building paper.

#### **2.02 WATER-RESISTIVE BARRIER MATERIALS (NEITHER AIR BARRIER NOR VAPOR RETARDER)**

- A. Building Paper: Asphalt-saturated Kraft building paper complying with requirements of ICC-ES AC38 Grade D.

#### **2.03 ACCESSORIES**

- A. Sealants, Tapes, and Accessories for Sealing Weather Barrier and Sealing Weather Barrier to Adjacent Substrates: As specified or as recommended by weather barrier manufacturer.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that surfaces and conditions are ready to accept the work of this section.

#### **3.02 PREPARATION**

- A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.

### **3.03 INSTALLATION**

- A. Install materials in accordance with manufacturer's instructions.
- B. Water-Resistive Barriers: Install continuous barrier over surfaces indicated, with sheets lapped to shed water but with seams not sealed.
- C. Mechanically Fastened Sheets - On Exterior:
  - 1) Install sheets shingle-fashion to shed water, with seams generally horizontal.
  - 2) Overlap seams as recommended by manufacturer but at least 6 inches.
  - 3) Overlap at outside and inside corners as recommended by manufacturer but at least 12 inches.
  - 4) Install water-resistive barrier over jamb flashings.

### **3.04 PROTECTION**

- A. Do not leave materials exposed to weather longer than recommended by manufacturer.
- B. Do not leave paper- or felt-based barriers exposed to weather for longer than one week.

**END OF SECTION**

## **SECTION 07 42 13 METAL WALL PANELS**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Manufactured metal panels for walls, with related flashings and accessory components.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 05 50 00 - Metal Fabrications: Tube steel support framing for wall panels.
- B. Section 06 10 00 - Rough Carpentry: Wood blocking.
- C. Section 07 62 00 - Sheet Metal Flashing and Trim: Wall cap.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Product data on each product specified.
- C. Shop Drawings: Indicate dimensions, layout, joints, construction details, methods of anchorage.
- D. Samples: Submit two samples of wall panel, 3" inch by 5" inch minimum in size illustrating finish color, sheen, and texture.
- E. Calculations:
  - 1) Include calculations with registered engineer seal, verifying wall panel and attachment method resist wind pressures imposed on it pursuant to applicable building codes.

#### **1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years of experience.
- B. Installer Qualifications: Company specializing in installing the products specified in this section with minimum five years of experience.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- B. Store prefinished material off ground and protected from weather. Prevent twisting, bending, or abrasion, and provide ventilation to stored materials. Slope metal sheets to ensure drainage.
- C. Prevent contact with materials that may cause discoloration or staining of products.

#### **1.07 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Material Warranty: Standard form in which manufacturer agrees to repair or replace items that fail in materials or workmanship within specified warranty replace items that

fail in materials or workmanship within specified warranty period. The items covered by the warranty include structural performance and finish performance.

- 1) Warranty Period: Two (2) years from date of Substantial Completion.
- C. Finish Warranty: Standard form in which manufacturer agrees to repair or replace metal panels that evidence deterioration of fluoropolymer finish, including flaking or peeling from approved primed metal substrate, chalk in excess of 8 when tested in accordance with ASTM D4214, Method A, and /or color fading in excess of 5 % Hunter units on panels when tested in accordance with ASTM D2244.
- 1) Warranty Period: Twenty (20) years from date Substantial Completion, or 20 years and 3 months from the date of shipment from manufacturer's plant, whichever occurs first.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Basis-of-Design; Product AEP Span - Nu-Wave Corrugated.
- B. Other Acceptable Manufacturers:
  - 1) Berridge Manufacturing Company.
  - 2) Substitutions: See Section 01 60 00 - 01 60 00.

### **2.02 MANUFACTURED METAL PANELS**

- A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
  - 1) Provide exterior panels.
  - 2) Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
  - 3) Design Pressure: In accordance with applicable codes.
  - 4) Maximum Allowable Deflection of Panel: 1/90 of span.
  - 5) Movement: Accommodate movement within system without damage to components or deterioration of seals, movement within system; movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
  - 6) Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
  - 7) Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
  - 8) Corners: Factory-fabricated in one continuous piece with minimum 18 inch returns.
  - 9) Exterior Finish:
    - a. DuraTech® 5000 (Polyvinylidene Fluoride), full 70% Kynar® 500/Hylar 5000® consisting of a baked-on 0.15-0.20 mil corrosion resistant primer and a baked-on 0.70-0.80 mil finish coat with a specular gloss of 10-30% when tested in accordance with ASTM D-523- 89 at 60°.
  - 10) Interior Finish:
    - a. Primer Coat Material: Corrosion-resistant primer; primer coat dry film thickness: 0.15 mils; finish coat material: polyester paint, finish coat dry film thickness: 0.35 mils.
    - b. Color:: Light Gray
- B. Exterior Panels:
  - 1) Profile: Horizontal; style as indicated.
  - 2) Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.

- 3) Material: Precoated steel sheet, 22 gage, 0.0299 inch minimum thickness.
- 4) Panel Width: 34-2/3" inches.
- 5) Color: As selected by Architect from manufacturer's standard line.
- C. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.
- D. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.
- E. Anchors: Galvanized steel.

## **2.03 MATERIALS**

- A. Precoated Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating; continuous coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.
- B. Protective Coating: Conform to ASTM A924 G-90 Galvanized.

## **2.04 ACCESSORIES**

- A. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant.
- B. Sealants:
  - 1) Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
  - 2) Concealed Sealant: Non-curing butyl sealant or tape sealant.
- C. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, stainless steel. Exposed fasteners same finish as panel system.
- D. Field Touch-up Paint: As recommended by panel manufacturer.
- E. Bituminous Paint: Asphalt base.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that framing members are ready to receive panels.

### **3.02 PREPARATION**

- A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane. Space at intervals indicated.

### **3.03 INSTALLATION**

- A. Install panels on walls in accordance with manufacturer's instructions.

### **3.04 TOLERANCES**

- A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.

### **3.05 CLEANING**

- A. Remove site cuttings from finish surfaces.
- B. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

## **END OF SECTION**





## **SECTION 07 62 00**

### **SHEET METAL FLASHING AND TRIM**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Fabricated sheet metal items, including flashings, counterflashings, and parapets.

##### **1.02 REFERENCE STANDARDS**

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels; 2013.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- C. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014.
- E. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.
- F. National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual. Latest edition.

##### **1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

##### **1.04 PROJECT CONDITIONS**

- A. Field Measurements: Before fabricating sheet metal, verify shapes and dimensions of surfaces to be covered.

##### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- B. Prevent contact with materials that could cause discoloration or staining.

#### **PART 2 PRODUCTS**

##### **2.01 SHEET MATERIALS**

- A. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gage (0.0239) inch thick base metal, shop pre-coated with PVDF coating.
  - 1) PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
  - 2) Color: As selected by Architect from manufacturer's full colors.

##### **2.02 ACCESSORIES**

- A. Fasteners: Same material and finish as flashing metal, with soft neoprene washers.
- B. Primer: Zinc chromate type.
- C. Sealant: Approved type of polyurethane; see Section 07 92 00.
- D. Solder: ASTM B32; Sn50 (50/50) type.

##### **2.03 FABRICATION**

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

- B. Fabricate cleats of same material as sheet, minimum 2 inches wide, interlocking with sheet.
- C. Form pieces in longest possible lengths.
- D. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- E. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- F. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Notification: Notify General Contractor of unsatisfactory conditions in writing with copy to Architect.

#### **3.02 PREPARATION**

- A. Install starter and edge strips, and cleats before starting installation.
- B. Protective Coating: Coat contacting dissimilar metals with asphaltic compound.

#### **3.03 INSTALLATION**

- A. Conform to drawing details.
- B. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.
- C. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- D. Seal metal joints watertight.

#### **3.04 FIELD QUALITY CONTROL**

- A. See Section 01 40 00 - Quality Requirements, for field inspection requirements.
- B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

**END OF SECTION**

## **SECTION 07 84 00 FIRESTOPPING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Firestopping systems.
- B. Firestopping of all joints and penetrations in fire resistance rated and smoke resistant assemblies, whether indicated on drawings or not, and other openings indicated.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 07 92 00 - Joint Sealants: For all other joint sealants.
- C. Section 09 21 16 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.
- D. Divisions 21, 22, 23, and 26: Fire Protection, Mechanical, Plumbing, and Electrical Work.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM E84 - Standard Test Methods for Surface Burning Characteristics of Building Materials; 2014.
- B. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2015.
- C. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2013a.
- D. ASTM E1966 - Standard Test Method for Fire Resistive Joint Systems; 2007 (Reapproved 2011).
- E. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus; 2015a.
- F. ITS (DIR) - Directory of Listed Products; current edition.
- G. FM 4991 - Approval Standard for Firestop Contractors; 2013.
- H. FA (AG) - FM Approval Guide; Factory Mutual Research Corporation; current edition.
- I. UL 1479 - Fire Tests of Through-Penetration Firestops.
- J. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.
- K. UL (FRD) - Fire Resistance Directory; current edition.

#### **1.04 PERFORMANCE REQUIREMENTS**

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items. Provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814:
  - 1) F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
  - 2) T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:

- C. L-rated systems are not required by model codes in effect when this Section was updated. L-ratings are used to determine effectiveness of firestop systems to resist passage of smoke or to further limit types of firestop systems that comply with requirements. Only UL 1479 currently includes test for L-ratings.
- D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
  - 1) For piping penetrations for plumbing provide moisture-resistant through-penetration firestop systems.
  - 2) For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- E. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, determined by ASTM E 84.
- F. Fire-Resistant Joint Sealants: Provide joint sealants with fire-resistant ratings indicated, as determined per ASTM E 119, but not less than that equaling or exceeding the fire-resistant rating of the construction in which the joint occurs.
- G. For fire-resistant systems exposed to view, provide products with flame-spread values of less than 25 and smoke-developed values of less than 450, as determined per ASTM E 84.
- H. Do not use any product containing solvents or that requires hazardous waste disposal.
- I. Do not use firestop products which after curing; dissolve in water.
- J. Firestopping shall be performed by a contractor trained or approved by the manufacturer.
- K. Equipment used shall be in accordance with the manufacturer's written installation instructions.
- L. Firestopping material shall be asbestos free and free of any PCBs.

#### **1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, firestopping test or design number, and manufacturers' engineering judgement.
- C. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- D. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.
  - 1) Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Installer Qualification: Submit qualification statements for installing mechanics.

## **1.06 QUALITY ASSURANCE**

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
  - 1) Listing in the current-year classification or certification books of UL or FM will be considered as constituting an acceptable test report.
  - 2) Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at [www.icc-es.org](http://www.icc-es.org) will be considered as constituting an acceptable test report.
  - 3) Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:
  - 1) Approved by Factory Mutual Research Corporation under FM 4991.
  - 2) With minimum 3 years documented experience installing work of this type.

## **1.07 FIELD CONDITIONS**

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.
- C. Where firestopping is installed at locations, which will remain exposed in the completed work, provide protection as necessary to prevent damage to adjacent surfaces and finishes, and protect as necessary against damage from other construction activities.

## **1.08 CERTIFICATION**

- A. Firestop Contractor shall provide written certification following completion of the Work that firestopping systems used for this project meet firestopping requirements as herein specified.

## **PART 2 PRODUCTS**

### **2.01 FIRESTOPPING - GENERAL REQUIREMENTS**

- A. Manufacturers:
  - 1) A/D Fire Protection Systems Inc.
  - 2) 3M Fire Protection Products.
  - 3) Hilti, Inc.
  - 4) Nelson FireStop Products.
  - 5) Grace, W.R. & Co.
  - 6) Specified Technologies, Inc.
  - 7) Tremco; Sealant / Weatherproofing Division
  - 8) Substitutions: See Section 01 60 00 - 01 60 00.
- B. Firestopping: Any material meeting requirements.
- C. Materials: Use any material meeting requirements.
- D. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

### **2.02 FIRE SAFING INSULATION**

- A. Compatibility: Provide fire safing that is compatible with fire sealant and substrates forming openings.

- B. Fire Safing Batt Insulation: Safing insulation combining mineral fibers of type described below to comply with ASTM C 612, Type III and E 84 .
  - 1) Mineral-Fiber Type: Fibers manufactured from slag, wool, or rock wool.
  - 2) Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indices of 25 and 50, respectively.

### **2.03 FIRE-RESISTIVE ELASTOMERIC JOINT SEALANTS**

- A. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer indicated that complies with ASTM C 920 requirements, including those referenced for Type, Grade, Class, and Uses, and requirements specified in this Section applicable to fire-resistant joint sealants.
- B. Sealant Colors: Provide color of exposed joint sealants to comply with the following:
  - 1) Provide selections made by Architect from manufacturer's full range of standard colors for products of type indicated.
- C. Single-Component, Neutral-Curing Silicone Sealant: Type S; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, G, A, and (as applicable to joint substrates indicated) O.
  - 1) Additional Movement Capability: Provide sealant with the capability to withstand the following percentage changes in joint width existing at time of installation, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, and remain in compliance with other requirements of ASTM C 920 for uses indicated:
    - a. 50 percent movement in both extension and compression for a total of 100 percent movement.
- D. Multicomponent, Nonsag, Urethane Sealant: Type M; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, A, and (as applicable to joint substrates indicated) O.
  - 1) Additional Movement Capability: Provide sealant with the capability to withstand the following percentage change in joint width existing at time of installation, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, and remain in compliance with other requirements of ASTM C 920 for uses indicated:
    - a. 40 percent movement in extension and 25 percent in compression for a total of 65 percent movement.
- E. Single-Component, Nonsag, Urethane Sealant: Type S; Grade NS; Class 25; and Uses NT, M, A, and (as applicable to joint substrates indicated) O.
- F. Products: Subject to compliance with requirements, provide one (1) of the following:
  - 1) Single-Component, Neutral-Curing, Silicone Sealant:
    - a. Dow Corning 790, Dow Corning Corp.
    - b. Dow Corning 795, Dow Corning Corp.
    - c. Silpruf, General Electric Co.
    - d. Ultraglaze, General Electric Co.
    - e. 864, Pecora Corp.
    - f. Fire Barrier Sealant 3M.
    - g. Substitutions: See Section 01 60 00 - 01 60 00.
  - 2) Multicomponent, Nonsag, Urethane Sealant:
    - a. Vulkem 922.
    - b. Dynflex, Pecora Corp.
    - c. Dynatred, Pecora Corp.
    - d. Dynatrol II, Pecora Corp.

- e. Sikaflex 2c NS, Sika Corp.
  - f. Sonolastic NP 2, Sonneborn Building Products.
  - g. Dymeric, Tremco Inc.
  - h. Fire Barrier Sealant 3M.
  - i. Substitutions: See Section 01 60 00 - 01 60 00.
- 3) Single-Component, Nonsag, Urethane Sealant:
- a. Isoflex 880 GB.
  - b. Isoflex 881.
  - c. Vulkem 921.
  - d. Sikaflex--15LM.
  - e. Fire Barrier Sealant 3M.
  - f. Substitutions: See Section 01 60 00 - 01 60 00.

#### **2.04 FIRESTOPPING ASSEMBLY REQUIREMENTS**

- A. Perimeter Fire Containment Firestopping: Use any system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of the floor assembly.
- B. Through Penetration Firestopping: Use any system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

#### **2.05 FIRESTOPPING FOR FLOOR-TO-FLOOR, WALL-TO-FLOOR, AND WALL-TO-WALL JOINTS**

#### **2.06 FIRESTOPPING SYSTEMS**

- A. Firestopping: Any material meeting requirements.
  - 1) Fire Ratings: Use any system that is listed by FM, ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814 or ASTM E119 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.
  - 2) Fire Ratings: See Drawings for required systems and ratings.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify openings are ready to receive the work of this section.

#### **3.02 PREPARATION**

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.

#### **3.03 INSTALLATION**

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

#### **3.04 FIELD QUALITY CONTROL**

- A. Independent Testing Agency: Inspection agency employed and paid by UCCS, will examine penetration firestopping in accordance with ASTM E2174, "Standard Practice for On-Site Inspection of Installed Fire Stops and ASTM E2393, "Standard Practice for On-Site Inspection of Installed Fire Stop Joint Systems.
- B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

#### **3.05 CLEANING**

- A. Clean adjacent surfaces of firestopping materials.

**3.06 PROTECTION**

- A. Protect adjacent surfaces from damage by material installation.

**END OF SECTION**



## **SECTION 07 92 00 JOINT SEALANTS**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES:**

- A. Section Includes: Providing all caulking and sealing indicated on Contract Drawings, specified herein, and not specified under other sections. In general, seal all openings indicated on drawings, between dissimilar materials, and at other locations requiring sealant to seal visually and against infiltration from air and water including but not limited to following:
  - 1) Flashing reglet and retainers.
  - 2) Exterior wall joints.
  - 3) Joints at penetrations of walls, decks and floors by piping and other service and equipment.
  - 4) Joints between items of equipment and other construction.
  - 5) Joints between door and window frames and adjacent materials, exterior and interior.
  - 6) Bedding for door thresholds.
  - 7) Open joints between dissimilar materials as required to close and conceal jointing of the work.
  - 8) Acoustical sealant at top and bottom of acoustical rated wall assemblies.
  - 9) Construction and expansion joints, joints between dissimilar materials; joints around windows, door frames, louvers, and other penetrations and openings in the exterior wall; interior walls as detailed or specified.
  - 10) Joints between casework and wall or as indicated on drawings.
  - 11) Perimeter joints of toilet fixtures and accessories.
  - 12) Other joints as indicated.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions: Additional requirements for sealants and primers.
- B. Section 07 84 00 - Firestopping: Firestopping sealants.
- C. Section 08 43 13 - Aluminum-Framed Storefronts: Sealant between storefront frame and adjacent construction.
- D. Section 08 71 00 - Door Hardware: Setting exterior door thresholds in sealant.
- E. Section 08 80 00 - Glazing: Glazing sealants and accessories.
- F. Section 09 21 16 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.
- G. Section 09 22 16 - Non-Structural Metal Framing: Sealing between framing and adjacent construction in acoustical and sound-rated walls and ceilings.
- H. Section 09 30 00 - Tiling: Sealant between tile and plumbing fixtures and at junctions with other materials and changes in plane.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2006 (Reapproved 2011).
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2012.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2013.

- E. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2002 (Reapproved 2013).

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.
  - 1) Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
  - 2) List of backing materials approved for use with the specific product.
  - 3) Substrates that product is known to satisfactorily adhere to and with which it is compatible.
  - 4) Substrates the product should not be used on.

#### **1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

#### **1.06 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective work within a five year period after Date of Substantial Completion.
- C. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal , exhibit loss of adhesion or cohesion, or do not cure.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Non-Sag Sealants: Permits application in joints on vertical surfaces without sagging or slumping.
  - 1) C.R. Laurence Co., Inc.
  - 2) DAP Inc.
  - 3) Dow Corning Corporation.
  - 4) Pecora Corporation.
  - 5) Sonneborn Building Products.
  - 6) Tremco Global Sealants.
  - 7) Sika Corporation.
  - 8) Substitutions: See Section 01 60 00 - 01 60 00.
- B. Self-Leveling Sealants: Pourable or self-leveling sealant that has sufficient flow to form a smooth, level surface when applied in a horizontal joint.
  - 1) C.R. Laurence Co., Inc.
  - 2) DAP Inc.
  - 3) Dayton Superior Corporation.
  - 4) Dow Corning Corporation.
  - 5) Pecora Corporation.
  - 6) Tremco Global Sealants.
  - 7) Sika Corporation.
  - 8) Substitutions: See Section 01 60 00 - 01 60 00.

#### **2.02 JOINT SEALANT APPLICATIONS**

- A. Scope:

- 1) Exterior Joints: Seal open joints, whether or not the joint is indicated on the drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
    - a. Joints between door, window, and other frames and adjacent construction.
    - b. Joints between different exposed materials.
    - c. Other joints indicated below.
  - 2) Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
    - a. Joints between door, window, and other frames and adjacent construction.
    - b. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
    - c. Other joints indicated below.
  - 3) Do not seal the following types of joints.
    - a. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
    - b. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
    - c. Joints where installation of sealant is specified in another section.
    - d. Joints between suspended panel ceilings/grid and walls.
- B. Exterior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.
- 1) Control and Expansion Joints in Concrete Paving: Self-leveling polyurethane "traffic-grade" sealant.
- C. Sound-Rated Assemblies: Walls and ceilings identified as "STC-rated", "sound-rated", or "acoustical".

### **2.03 JOINT SEALANTS - GENERAL**

- A. Sealants and Primers: Provide products with levels of volatile organic compound (VOC) content as indicated in Section 01 61 16.

### **2.04 NONSAG JOINT SEALANTS**

- A. Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
- 1) Applications: Interior sealant where not noted otherwise.
  - 2) Movement Capability: Plus and minus 25 percent, minimum.
  - 3) Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
  - 4) Color: To be selected by Architect from manufacturer's standard range.
  - 5) Cure Type: Single-component, neutral moisture curing
  - 6) Service Temperature Range: Minus 65 to 180 degrees F.
- B. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Class 25, Uses NT; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
- 1) Applications: Mildew-resistant to be used in toilet and custodial rooms. (Toilets, urinals, lavatories, countertops, and as indicated on Contract Drawings)
  - 2) Color: White.
- C. Polyurethane Sealant: ASTM C920, Grade NS, Type II, Uses M and A; single component; not expected to withstand continuous water immersion or traffic.
- 1) Applications: Metal flashings and as indicated on Contract Drawings and for exterior applications not identified.
  - 2) Movement Capability: Plus and minus 25 percent, minimum.
  - 3) Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.

- 4) Color: To be selected by Architect from manufacturer's standard range.
  - 5) Service Temperature Range: Minus 40 to 180 degrees F.
- D. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, non-staining, non-bleeding, non-sagging; not intended for exterior use.
- 1) Applications: Interior door and window frame, and as indicated on Contract Drawings.
  - 2) Color: To be selected by Architect from manufacturer's standard range.
  - 3) Grade: ASTM C834; Grade - Minus 18 Degrees C.
- E. Acoustical Sealant: Acrylic Emulsion Latex or water-based elastomeric sealant; ASTM C834, single component, non-staining, non-bleeding, non-sagging; not intended for exterior use.
- 1) Applications: Base and head of acoustical walls, interior door and window frames in acoustical wall construction, and where indicated on Contract Drawings.
  - 2) Color: To be selected by Architect from manufacturer's standard range.
  - 3) Cure Type: Single-component, neutral moisture curing
  - 4) Grade: ASTM C834; Grade - Minus 18 Degrees C.
  - 5) Manufacturers:
    - a. Franklin International, Inc; Titebond GREENchoice Acoustical Smoke & Sound Sealant.
    - b. Hilti, Inc; CP 506 Smoke and Acoustical Sealant.
    - c. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
    - d. Substitutions: See Section 01 60 00 - 01 60 00.

## 2.05 SELF-LEVELING SEALANTS

- A. Self-Leveling Polyurethane Sealant: ASTM C920, Grade P, Type I, Class A. Uses M and A; single component; explicitly approved by manufacturer for traffic exposure; not expected to withstand continuous water immersion .
- 1) Applications: Interior floor slab control joints.
  - 2) Movement Capability: Plus and minus 35 percent, minimum.
  - 3) Hardness Range: 35 to 55, Shore A, when tested in accordance with ASTM C661.
  - 4) Color: To be selected by Architect from manufacturer's standard range.
  - 5) Service Temperature Range: Minus 40 to 180 degrees F.
- B. Rigid Self-Leveling Polyurethane Joint Filler: Two part, low viscosity, fast setting; intended for cracks and control joints not subject to significant movement.
- 1) Hardness Range: Greater than 100, Shore A, and 50 to 80, Shore D, when tested in accordance with ASTM C661.
  - 2) Applications: Concrete paving and sidewalks.
  - 3) Color: To be selected by Architect from manufacturer's standard range.

## 2.06 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
- 1) Type for Joints Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type B - Bi-Cellular Polyethylene.
  - 2) Closed Cell and Bi-Cellular: 25 to 33 percent larger in diameter than joint width.
  - 3) Manufacturers:
    - a. Dow Chemical Company.
    - b. Sonneborn.
    - c. Denver Foam.
    - d. Schlegel Manufacturing Company

- e. Substitutions: See Section 01 60 00 - 01 60 00.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, non-staining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Non-corrosive and non-staining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- E. Primers: Type recommended by sealant manufacturer to suit application; non-staining.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.
- D. Notification: Notify General Contractor of any joints that cannot be put into proper condition to receive sealants in writing with copy to Architect.

#### **3.02 PREPARATION**

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

#### **3.03 INSTALLATION**

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.
- C. Perform acoustical sealant application work in accordance with ASTM C919.
- D. Install bond breaker backing tape where backer rod cannot be used.
- E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- F. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- G. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

#### **3.04 FIELD QUALITY CONTROL**

- A. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.
- B. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

### **3.05 CLEANING**

- A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

### **3.06 PROTECTION**

- A. Protection:
  - 1) Advise General Contractor of procedures required for protection of sealants during construction period, so that they will be without deterioration or damage (other than normal weathering) at time of acceptance.
  - 2) Protect surfaces from damage. Clean soiled surfaces immediately. Replace any damaged material that cannot be cleaned with new material.

**END OF SECTION**

## **SECTION 08 11 13**

### **HOLLOW METAL DOORS AND FRAMES**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Non-fire-rated hollow metal doors and frames.
- B. Hollow metal frames for wood doors.
- C. Thermally insulated hollow metal doors with frames.
- D. Sound-rated hollow metal doors and frames.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 08 71 00 - Door Hardware.
- B. Section 09 21 16 - Gypsum Board Assemblies.
- C. Section 09 91 13 - Exterior Painting: Field painting.
- D. Section 09 91 23 - Interior Painting: Field painting.

##### **1.03 ABBREVIATIONS AND ACRONYMS**

- A. ANSI - American National Standards Institute.
- B. HMMA - Hollow Metal Manufacturers Association.
- C. NAAMM - National Association of Architectural Metal Manufacturers.
- D. NFPA - National Fire Protection Association.
- E. SDI - Steel Door Institute.
- F. UL - Underwriters Laboratories.

##### **1.04 REFERENCE STANDARDS**

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2011.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2014.
- D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2011.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- F. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009.
- G. ASTM E413 - Classification for Rating Sound Insulation; 2010.
- H. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2009.
- I. NAAMM HMMA 840 - Guide Specifications for Installation and Storage of Hollow Metal Doors and Frames; 2007.
- J. NAAMM HMMA 860 - Guide Specifications for Hollow Metal Doors and Frames; 2013.
- K. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2006.
- L. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2012.

## **1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- D. Door Schedule: Submit schedule of doors with frames using same reference numbers for details and openings as those on Contract Drawings.
- E. Templates: Hardware templates for hardware mounted on hollow metal work shall be submitted under Section 08 71 00, Door Hardware directly to hollow metal manufacturer immediately after acceptance of hardware schedule. Report failure to receive templates with reasonable promptness to General Contractor.

## **1.06 QUALITY ASSURANCE**

- A. Provide doors and frames complying with ANSI/SDI 100 "Recommended Specifications for Standard Steel Doors and Frames" and as specified.
- B. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes installation requirements.
- C. Regulatory Requirements:
  - 1) Fire Rating: Provide fire rating label acceptance to local building code authority on doors and frames indicated on the door schedule. If any door or frame scheduled to be fire-rated cannot qualify for appropriate labeling because of its design, hardware, or any other reason, advise Architect prior to submission of bids.
  - 2) NFPA Standard No. 80.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Hollow Metal Doors and Frames:
  - 1) Amweld Building Products, Inc.
  - 2) Assa Abloy Ceco or Curries.
  - 3) Deansteel Manufacturing Co.
  - 4) Gateway Metal Products.
  - 5) Rocky Mountain Metals, Inc.
  - 6) Southwestern Hollow Metals.
  - 7) Steelcraft, an Allegion brand.
  - 8) Substitutions: See Section 01 60 00 - 01 60 00.

### **2.02 DESIGN CRITERIA**

- A. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.



### 2.03 HOLLOW METAL DOORS

- A. Exterior Doors: Thermally insulated.
  - 1) Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
    - a. Level 3 - Extra Heavy-duty.
    - b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
    - c. Model 1 - Full Flush.
    - d. Door Face Metal Thickness: 16 gage, 0.053 inch, minimum.
    - e. Zinc Coating: A60/ZF180 galvanized coating; ASTM A653/A653M.
  - 2) Core: Polyurethane.
  - 3) Door Thermal Resistance: R-Value of 8.7, minimum, for installed thickness of polyurethane.
  - 4) Door Thickness: 1-3/4 inch, nominal.
  - 5) Top Closures for Outswinging Doors: Flush with top of faces and edges.
  - 6) Weatherstripping: Refer to Section 08 71 00.
  - 7) Door Finish: Factory primed and field finished.
- B. Sound-Rated Interior Doors:
  - 1) Sound Transmission Class (STC) Rating of Door and Frame Assembly: STC of 35, calculated in accordance with ASTM E413, and tested in accordance with ASTM E90.
  - 2) Core Material: Manufacturer's standard construction as required to meet acoustic requirements indicated.
  - 3) Door Thickness: As required to meet acoustic requirements indicated.
  - 4) Door Face Sheets: Flush.
  - 5) Door Finish: Factory primed and field finished.
  - 6) Sound Seals: Integral, concealed in door and/or frame.
  - 7) Opening Force of Sound-Rated Doors, Non-Fire Rated: 5 lbs, maximum, in compliance with ADA Standards.

### 2.04 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. General:
  - 1) Do not use exposed screws.
  - 2) Accessories:
    - a. Reinforcement for Hardware: Machine frames for attachment of hardware, including mortising, reinforcing, drilling and tapping for hinges.
      - 1) Butt Hinges: Seven gauge, 12" long, full width of frame.
      - 2) Closers: 10 ga., 12" long, full width of frame.
      - 3) Strikes, Flush Bolts and Other Surface Mounted Hardware: 12 ga.
    - b. Anchors: Furnish anchors of type and number required for anchoring frames to structure, partitions, etc., as follows:

Frame Height	Masonry / Concrete	Stud Frame
up to 7'-0"	3 per jamb	4 per jamb
up to 8'-0"	4 per jamb	5 per jamb
over 8'-0"	Add one anchor per 24" or fraction	

- C. Exterior Door Frames: Fully welded.

- 1) Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A60/ZF180 coating.
  - 2) Frame Metal Thickness: 14 gage, 0.067 inch, minimum.
  - 3) Frame Finish: Factory primed and field finished.
  - 4) Weatherstripping: Separate, see Section 08 71 00.
- D. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
- 1) Terminated Stops: At floor line.
  - 2) Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
  - 3) Frame Finish: Factory primed and field finished.
- E. Sound-Rated Door Frames: Full profile/continuously welded type.
- 1) Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
  - 2) Frame Finish: Factory primed and field finished.
- F. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- G. Mullions for Pairs of Doors: Removable type, of profile similar to jambs. See Section 08 71 00, Door Hardware.
- H. Prepare frame with drilled holes for silencers. 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions. Do not drill holes in frames for exterior use with weatherstripping.

## **2.05 ACCESSORIES**

- A. Astragals for Double Doors: Specified in Section 08 71 00.
- B. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

## **2.06 FINISHES**

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

### **3.02 INSTALLATION**

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Coordinate frame anchor placement with wall construction.
- C. Coordinate installation of hardware.
- D. Coordinate installation of electrical connections to electrical hardware items.
- E. In precast, and concrete, construction, install at least three (3) wall anchors per jamb adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Install with expansion or sleeve anchors with heads exposed on the frame surface shall have bolt head depressions filled with automotive body putty filler and sanded smooth so fasteners are not visible.
- F. Touch up damaged factory finishes.
- G. Provide sealant between bottom of frame and threshold.

### **3.03 TOLERANCES**

- A. Clearances Between Door and Frame: As indicated in ANSI/SDI A250.8 (SDI-100) and NFPA 80 for rated doors.
- B. Maximum Diagonal Distortion: 1/16 in measured with straight edge, corner to corner.

### **3.04 ADJUSTING**

- A. Adjust for smooth and balanced door movement.
- B. Doors: Apply hardware in conformance with hardware manufacturer's templates and instructions. Hang doors to be free of binding with hardware functioning properly.
  - 1) Clearance Tolerances:
    - a. Head: 1/8" maximum, 3/32" preferred.
    - b. Jamb: 1/8" maximum.
    - c. Between Doors (Pair): 1/8" maximum.
    - d. Bottom at Decorative Floor Finish or Covering: 1/2" maximum measured from floor finish.
    - e. Sill With Threshold: 1/4" maximum, 1/8" preferred.
- C. Adjust sound control doors so that seals are fully engaged when door is closed.
- D. Prime Coat Touchup: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

### **3.05 SCHEDULE**

- A. Refer to Door and Frame Schedule on the drawings.

**END OF SECTION**



## **SECTION 08 14 16**

### **FLUSH WOOD DOORS**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Flush wood doors; flush configuration; fire rated and non-rated.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 08 11 13 - Hollow Metal Doors and Frames. Frame for wood door.
- B. Section 08 71 00 - Door Hardware.

##### **1.03 REFERENCE STANDARDS**

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2014.
- B. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2016.
- C. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- D. WDMA I.S. 1A - Interior Architectural Wood Flush Doors; 2013.

##### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
  - 1) Provide the information required by AWI/AWMAC/WI (AWS).
- D. Specimen warranty.
- E. Samples: Submit two samples of door veneer, 12 by 12 inch in size illustrating wood grain, stain color, and sheen from manufacturer's full range of standard colors and finishes on wood grain specified for Architects selection.
- F. Templates: Hardware templates for hardware mounted on wood doors will be submitted under Section 08 71 00, Door Hardware directly to wood door manufacturer immediately after acceptance of hardware schedule. Report failure to receive templates with reasonable promptness to General Contractor.
- G. Warranty, executed in UCCS's name.

##### **1.05 QUALITY ASSURANCE**

- A. Installed Fire Rated Door Assembly: Conform to NFPA 80 for fire-rating as indicated.

##### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Package, deliver and store doors in accordance with specified quality standard.
- B. Accept doors on site in manufacturer's packaging. Inspect for damage.
- C. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation.

##### **1.07 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Interior Doors: Provide manufacturer's warranty for the life of the installation.

- C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, telegraphing core construction, and deviation from National Woodwork Manufacturers Association (NWMA) or Architectural Woodwork Institute (AWI) tolerances.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Wood Veneer Faced Doors:
  - 1) Algoma Hardwoods, Inc.
  - 2) Eggers Industries.
  - 3) Marshfield DoorSystems, Inc.
  - 4) Oshkosh Architectural Door Co.
  - 5) VT Industries, Inc.
  - 6) Substitutions: See Section 01 60 00 - 01 60 00.

### **2.02 DOORS**

- A. Doors: See drawings for locations and additional requirements.
  - 1) Quality Level: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS).
  - 2) Wood Veneer Faced Doors: 5-ply or 7-ply unless otherwise indicated.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
  - 1) Provide solid core doors at each location.
  - 2) Fire Rated Doors: Tested to 20 minutes, 60 minutes, 90 minutes, and ratings as indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc. (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.
  - 3) Wood veneer facing for field transparent finish as indicated on drawings.
  - 4) Under Cutting: Preserve full bottom rail.

### **2.03 DOOR AND PANEL CORES**

- A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.
- B. Fire Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

### **2.04 DOOR FACINGS**

- A. Veneer Facing for Transparent Finish: Red oak, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.
  - 1) Vertical Edges: Same species as face veneer.

### **2.05 DOOR CONSTRUCTION**

- A. Fabricate doors in accordance with door quality standard specified.
- B. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- C. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- D. Provide edge clearances in accordance with the quality standard specified.

## **2.06 FACTORY FINISHING - WOOD VENEER DOORS**

- A. Finish work in accordance with AWI/AWMAC/WI (AWS), Section 5 - Finishing for grade specified and as follows:
  - 1) Transparent:
    - a. Grade: Custom.
    - b. System - 5, Varnish, Conversion.
    - c. Stain: As selected by Architect.
    - d. Sheen: dull rubbed.
    - e. Effect: Open-grain finish.
- B. Factory finish doors in accordance with approved sample.
- C. Seal door top edge with color sealer to match door facing.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.
- D. Notification: Notify General Contractor of unsatisfactory conditions in writing with copy to Architect.

### **3.02 PREPARATION**

- A. Conditioning: Condition doors to average humidity in installation area for at least 48 hours prior to hanging.
- B. Prefitting: Prefit doors to frames and machine for hardware to whatever extent not previously worked at factory as required for proper fit and uniform clearance at each edge.
- C. Sealing: Before installation of hardware, brush apply exterior seal coat to all job site cut or planned surfaces within 48 hours of cut.
  - 1) Sealer: Type recommended by manufacturer.

### **3.03 INSTALLATION**

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
  - 1) Install fire-rated doors in accordance with NFPA 80 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.

### **3.04 TOLERANCES**

- A. Conform to specified quality standard for fit and clearance tolerances.
- B. Conform to specified quality standard for telegraphing, warp, and squareness.
- C. Clearance:
  - 1) Non-Fire Rated Doors:
    - a. Jamb: 3/32" preferred, 1/8" maximum, 1/8" bevel in two (2) inches.
    - b. Head: 3/32" preferred, 1/8" maximum.
    - c. Between Double Doors: 1/8", maximum.

- d. Bottom at Decorative Floor Finish or Covering: 1/2" maximum measured from floor finish.
  - e. Bottom at Threshold: 1/8" preferred, 1/4" maximum between bottom of door and top of threshold.
- 2) Fire Rated Doors: Comply with NFPA 80 and jurisdiction having authority.

**3.05 ADJUSTING**

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

**3.06 SCHEDULE**

- A. Refer to Door and Frame Schedule appended to the Contract Drawings.

**END OF SECTION**



## **SECTION 08 31 00**

### **ACCESS DOORS AND PANELS**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Wall access door and frame units.
- B. Ceiling access door and frame units.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 09 21 16 - Gypsum Board Assemblies: Openings in gypsum board walls and ceilings.
- B. Section 09 91 23 - Interior Painting: Field paint finish.
- C. Divisions 21, 22, 23, and 26 for access doors to MEP work. See individual Sections for access location criteria.

##### **1.03 REFERENCE STANDARDS**

- A. ITS (DIR) - Directory of Listed Products; current edition.
- B. UL (FRD) - Fire Resistance Directory; current edition.

##### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- C. Shop Drawings: Indicate exact position of each access door and/or panel unit.
- D. Project Record Documents: Record actual locations of all access units. Indicate size and type of panel at each location.

##### **1.05 QUALITY ASSURANCE**

- A. Single-Source Responsibility: Obtain access doors for entire Project from one source and by a single manufacturer.
- B. Fire-Rated Door Assemblies: Units that comply with NFPA 80, are identical to door and frame assemblies tested for fire-test-response characteristics per test method as indicated below, and are labeled and listed by UL, Warnock Hersey, or another testing and inspecting agency acceptable to authorities having jurisdiction.
  - 1) Test Method for Vertical Installations: NFPA 151, UL 10B, ASTM E 152.
  - 2) Test Method for Horizontal Installations: NFPA 288, ASTM E 119.
- C. Size Variations: Obtain Architect's acceptance of manufacturer's standard size units, which may vary slightly from sizes indicated.

##### **1.06 COORDINATION**

- A. Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified under "Submittals" Article.
- B. Furnish inserts and anchoring devices that must be built into other work for installation of access doors.
- C. Coordinate delivery with other work to avoid delay.

#### **PART 2 PRODUCTS**

##### **2.01 ACCESS DOOR AND PANEL APPLICATIONS**

- A. Walls, Unless Otherwise Indicated:
  - 1) Material: Steel.

- 2) Size: 12 by 12 inch, unless otherwise indicated.
  - 3) Standard duty, hinged door.
  - 4) Tool-operated spring or cam lock; no handle.
  - 5) In All Wall Types: Surface mounted face frame and door surface flush with frame surface.
- B. Walls in Wet Areas:
- 1) Material: Stainless steel.
  - 2) Size: 12 by 12 inch, unless otherwise indicated.
  - 3) Standard duty, hinged door.
  - 4) Tool-operated spring or cam lock; no handle.
  - 5) In All Wall Types: Surface mounted face frame and door surface flush with frame surface.
- C. Fire Rated Walls: See drawings for wall fire ratings.
- 1) Material: Steel.
  - 2) Size: 12 by 12 inch, unless otherwise indicated.
  - 3) Insulated, double skin door panel.
  - 4) Tool-operated spring or cam lock; no handle.
- D. Ceilings, Unless Otherwise Indicated: Same type as for walls.
- 1) Material: Steel.
  - 2) Size in Other Ceilings: 12 by 12 inch, unless otherwise indicated.
  - 3) Standard duty, hinged door.
  - 4) Tool-operated spring or cam lock; no handle.
- E. Fire Rated Ceilings: See drawings for ceiling fire ratings.
- 1) Material: Steel.
  - 2) Size: 12 by 12 inch, unless otherwise indicated.
  - 3) Standard duty, hinged door.
  - 4) Tool-operated spring or cam lock; no handle.

## 2.02 WALL AND CEILING UNITS

- A. Manufacturers:
- 1) Acudor Products Inc.
  - 2) Babcock-Davis.
  - 3) Cendrex, Inc.
  - 4) Karp Associates, Inc.
  - 5) Milcor by Commercial Products Group of Hart & Cooley, Inc.
  - 6) J.L. Industries, Inc..
  - 7) Nystrom Inc..
  - 8) Substitutions: See Section 01 60 00 - 01 60 00.
- B. Access Doors: Factory fabricated door and frame units, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies that units are to be installed in.
- 1) Material: Steel. ASTM A 366 commercial-quality, cold-rolled steel sheet with baked-on, rust-inhibitive primer unless noted otherwise.
  - 2) Material: Zinc-Coated Steel Sheet. ASTM A591, Electrolytic zinc-coated steel sheet with Class C coating and phosphate treatment to prepare surface for painting where noted or at surfaces receiving special coating.
  - 3) Stainless Steel: Fabricate from not less than 14-gage stainless steel.
  - 4) Style: Exposed frame with door surface flush with frame surface.
  - 5) Door Style: Single thickness with rolled or turned in edges.
  - 6) Frames: 16 gage, 0.0598 inch, minimum.

- 7) Single Thickness Steel Door Panels: 0.0781 inch, minimum.
- 8) Double-Skinned Hollow Steel Door Panels: 16 gage, 0.059 inch, minimum, on both sides and each edge.
- 9) Insulation: Non-combustible mineral or glass fiber.
- 10) Units in Fire Rated Assemblies: Fire rating as required by applicable code for the fire rated assembly that access doors are being installed.
  - a. Provide products listed by ITS (DIR) or UL (FRD) as suitable for the purpose indicated.
- 11) Steel Finish: Primed.
- 12) Stainless Steel Finish: No. 4 brushed finish.
- 13) Size: 12"x12" unless otherwise indicated on drawings or as required to properly service mechanical or electrical equipment or reset dampers..
- 14) Hardware:
  - a. Hardware for Fire Rated Units: As required for listing.
  - b. Hinges for Non-Fire-Rated Units: Continuous piano hinge.
  - c. Hinges for Fire-Rated Units: Provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism. Rating to match that of adjacent wall construction.
  - d. Latch/Lock: Screw driver slot for quarter turn cam latch.
  - e. Key operated cam locks. All access doors to be keyed alike.
  - f. Number of Locks/Latches Required: As recommended by the manufacturer for the size of the unit.
  - g. Gasketing: Extruded neoprene, around the perimeter of the door panel.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Advise Installers of other work about specific requirements relating to access door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices. Furnish inserts and anchoring devices for access doors that must be built into other construction. Coordinate delivery with other work to avoid delay.

### **3.02 EXAMINATION**

- A. Verify that rough openings are correctly sized and located.

### **3.03 INSTALLATION**

- A. Install prime painted panels in walls and ceilings except where stainless steel panels are called to be installed.
- B. Install stainless steel panels in wet environments such as custodial rooms, kitchen, toilet rooms, showers, etc.
- C. Install units in accordance with manufacturer's instructions.
- D. Install frames plumb and level in openings. Secure rigidly in place.
- E. In addition to access panels located on Contract Drawings, and coordinated with other trades, provide access panels no further than 12 inches from any valve.
- F. Position units to provide convenient access to the concealed work requiring access.

## **END OF SECTION**



## **SECTION 08 33 23**

### **OVERHEAD COILING DOORS**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Overhead coiling doors, operating hardware, exterior, manual and electric operation.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 79 00 - Demonstration and Training.
- B. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.
- C. Section 08 71 00 - Door Hardware: Cylinder cores and keys.
- D. Section 09 91 23 - Interior Painting: Field paint finish.

##### **1.03 REFERENCE STANDARDS**

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- B. UL (DIR) - Online Certifications Directory; current listings at [database.ul.com](http://database.ul.com).

##### **1.04 DEFINITIONS**

- A. Operation Cycle: One complete cycle of a door begins with the door in the closed position. The door is then moved to the open position and back to the closed position.

##### **1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide general construction, electrical equipment, and component connections and details.
- C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
- D. Samples: Submit color samples of manufacturer's full range of standard colors for Architect's color selection.
- E. Samples: Submit two slats, 12" inch in size illustrating shape, color and finish texture.
- F. Manufacturer's Installation Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.
- G. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

##### **1.06 QUALITY ASSURANCE**

- A. Operation-Cycle Requirements: Design overhead coiling door components and operator to operate for not less than 50,000 cycles.
- B. Operation-Cycle Requirement for Counter Door: Design rolling counter door components and operator to operate to a standard maximum 10 cycles per day and an overall maximum of 20,000 operating cycles for the life of the door.
- C. Installer Qualifications: Engage an experienced installer who is an authorized representative of the overhead coiling door manufacturer for both installation and maintenance of units required for this Project.
- D. Source Limitations: Obtain overhead coiling doors through one source from a single manufacturer.

- 1) Obtain operators and controls from the overhead coiling door manufacturer. Coordinate door controls with electrical sub-contractor.
- E. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.
- F. Fire-Rated Door Assemblies: Provide assemblies complying with NFPA 80 that are identical to door and frame assemblies tested for fire-test-response characteristics per UL 10b, and that are labeled and listed for fire ratings indicated by UL, FM, ITS/Warnock Hersey, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- G. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.
  - 1) The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
  - 2) Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Overhead Coiling Doors:
  - 1) Cornell Iron Works, Inc.
  - 2) Raynor Garage Doors
  - 3) The Cookson Company.
  - 4) Wayne-Dalton, a Division of Overhead Door Corporation.
  - 5) Mahon Door Corporation.
  - 6) Substitutions: See Section 01 60 00 - 01 60 00.

### **2.02 COILING DOORS**

- A. Exterior Coiling Doors: Steel slat curtain.
  - 1) Sandwich slat construction with insulated core of foamed-in-place polyurethane insulation; minimum R-value of 8.1.
  - 2) Nominal Slat Size: 2 inches wide x required length.
  - 3) Finish: Factory painted, color as selected.
  - 4) Guides: Angles, galvanized steel.
  - 5) Hood Enclosure: Manufacturer's standard; primed steel.
  - 6) Manual hand chain lift operation as back-up to electric operator
  - 7) Electric operation. Existing
  - 8) Mounting: Within framed opening.
  - 9) Locking Devices: Slide bolt on inside.

### **2.03 MATERIALS**

- A. Curtain Construction: Interlocking slats.
  - 1) Slat Ends: Each slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
  - 2) Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
    - a. Astragal: Replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene; as a cushion bumper for interior door.
  - 3) Weatherstripping: Moisture and rot proof, resilient type, located at bottom of curtain and where curtain enters hood enclosure of exterior doors. Exterior applications only.
- B. Steel Slats: Minimum thickness, 22 gage, 0.0313 inch; ASTM A653/A653M galvanized steel sheet.

- 1) Slat Type: flat
- C. Guide Construction: Continuous, of profile to retain door in place of steel angles and channels, mounting brackets of same metal. Prime paint.
- D. Hood Enclosure: Internally reinforced to maintain rigidity and shape.
  - 1) Minimum thickness; 23 gage, 0.0281" inch.
  - 2) Prime paint.
  - 3) Include automatic drop baffle to guard against passage of smoke or flame at rated doors.
- E. Lock Hardware:
  - 1) For motor operated units, additional lock or latching mechanisms are not required.
  - 2) Slide Bolt: Provide on single-jamb side, extending into slot in guides, with padlock on one side.
- F. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

#### **2.04 ELECTRIC OPERATION**

- A. Electric Operator: connect new door to existing door operator.
- B. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that opening sizes, tolerances and conditions are acceptable.

#### **3.02 INSTALLATION**

- A. Install units in accordance with manufacturer's instructions.
- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
- D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- E. Coordinate installation of electrical service with Section 26 27 17.
- F. Complete wiring from disconnect to unit components.
- G. Install perimeter trim and closures.

#### **3.03 TOLERANCES**

- A. Maintain dimensional tolerances and alignment with adjacent work.
- B. Maximum Variation From Plumb: 1/16 inch.
- C. Maximum Variation From Level: 1/16 inch.
- D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

#### **3.04 ADJUSTING**

- A. Adjust operating assemblies for smooth and noiseless operation.

### **3.05 DEMONSTRATION**

- A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train Owner's maintenance personnel as specified below:
  - 1) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 2) Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance, and procedures for testing and resetting release devices.
  - 3) Review data in the maintenance manuals. Refer to Section
    - a. 01 79 00, Demonstration and Training.
  - 4) Schedule training with Owner with at least seven (7) days' advance notice.

### **3.06 CLEANING**

- A. Clean installed components.
- B. Remove labels and visible markings.

**END OF SECTION**



## **SECTION 08 43 13**

### **ALUMINUM-FRAMED STOREFRONTS**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Aluminum-framed storefront, with vision glass.
- B. Aluminum doors.
- C. Weatherstripping.
- D. Door hardware.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.
- B. Section 08 71 00 - Door Hardware: Hardware items other than specified in this section. Additional hardware to be installed under this Section.
- C. Section 08 71 13 - Power Door Operators.
- D. Section 08 80 00 - Glazing: Glass and glazing accessories.

##### **1.03 REFERENCE STANDARDS**

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; 2015.
- B. AAMA 501.2 - Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage; 2009.
- C. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2012.
- D. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.
- E. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.
- G. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).
- H. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2009).

##### **1.04 SYSTEM DESCRIPTION**

- A. Design Requirements for Entrances: Comply with requirements for high-traffic applications in heavy commercial areas, with products of the same manufacturer.
- B. Design Requirements for Exterior Storefront: Comply with requirements for wind-resistance of connections and framing with products of the same manufacturer.
- C. System Description:
  - 1) Design Criteria:
    - a. IBC 2015
    - b. Wind Speed 100 MPH
    - c. Exposure "C"
    - d. Wind Factor 1.0

## **1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, internal drainage details.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, hardware preparation, and field welding required.
  - 1) Provide schedule of doors, frames, and hardware using same reference numbers for details and openings as those on Contract Drawings.
- D. Samples of manufacturer's full range of standard colors and finishes for Architects color selection.
- E. Samples: Submit two samples 4" by 4" inches in size illustrating finished aluminum surface, glass, glazing materials.
- F. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- G. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
  - 1) Templates: Hardware templates for hardware mounted on aluminum doors and frames shall be submitted under Section 08 71 00 directly to aluminum door and frame manufacturer immediately after acceptance of hardware schedule. Report failure to receive templates with reasonable promptness to General Contractor.
- H. Warranty: Submit manufacturer warranty and ensure forms have been completed in UCCS's name and registered with manufacturer.

## **1.06 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of experience.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

## **1.08 FIELD CONDITIONS**

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

## **1.09 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide ten year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Aluminum-Framed Storefront and Doors:
  - 1) Kawneer North America; 601T.
  - 2) Substitutions: See Section 01 60 00 - 01 60 00.

### **2.02 STOREFRONT FOR ENTRY DOOR VESTIBULES**

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
  - 1) Glazing Rabbet: For 1 inch insulating glazing.
  - 2) Glazing Rabbet: For 1/4 inch monolithic glazing.
  - 3) Glazing Position: Centered (front to back). Glazing to exterior side.
  - 4) Finish: Class I natural anodized.
    - a. Factory finish all surfaces that will be exposed in completed assemblies.
  - 5) Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
  - 6) Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
  - 7) System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
  - 8) Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
  - 9) Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
  - 10) Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
- B. Performance Requirements:
  - 1) As noted in Part 1.
  - 2) Water Penetration Resistance: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 8 psf.
  - 3) Air Leakage: Maximum of 0.06 cu ft/min sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 psf pressure differential across assembly.

### **2.03 STOREFRONT FOR WINDOWS**

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
  - 1) Glazing Rabbet: For 1 inch insulating glazing.
  - 2) Glazing Position: Centered (front to back). Glazing to exterior side.
  - 3) Finish: Class I natural anodized.
    - a. Factory finish all surfaces that will be exposed in completed assemblies.
  - 4) Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
  - 5) Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.

- 6) System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
  - 7) Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
  - 8) Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
  - 9) Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
- B. Performance Requirements:
- 1) As noted in Part 1.
  - 2) Water Penetration Resistance: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 8 psf.
  - 3) Air Leakage: Maximum of 0.06 cu ft/min sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 psf pressure differential across assembly.

## 2.04 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, drainage holes and internal weep drainage system.
- 1) Glazing Stops: Flush.
- B. Glazing: As specified in Section 08 80 00.
- C. Swing Doors: Exterior.
- 1) Basis-of-Design: Kawneer 360 Insulclad Thermal Entrance
  - 2) Thickness: 2-1/4" inches.
  - 3) Top Rail: 4-1/16" inches wide.
  - 4) Vertical Stiles: 4-1/16" inches wide.
  - 5) Bottom Rail: 10" inches wide.
  - 6) Glazing Stops: Square.
  - 7) Finish: Same as storefront.
- D. Swing Doors: Interior.
- 1) Basis-of-Design: Kawneer 360 Insulclad Thermal Entrance
  - 2) Thickness: 2-1/4" inches.
  - 3) Top Rail: 4-1/16" inches wide.
  - 4) Vertical Stiles: 4-1/16" inches wide.
  - 5) Bottom Rail: 10 inches wide.
  - 6) Glazing Stops: Square.
  - 7) Finish: Same as storefront.

## 2.05 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Fasteners: Stainless steel. Color to match adjacent frame color.
- C. Exposed Flashings: Aluminum sheet, 20 gage, 0.032 inch minimum thickness; finish to match framing members.
- D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

## **2.06 FINISHES**

- A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.
- B. Touch-Up Materials: As recommended by coating manufacturer for field application.

## **2.07 HARDWARE**

- A. Exterior Vestibule Doors:
  - 1) For each door, include weatherstripping and sill sweep strip.
    - a. Continuous Hinge.
    - b. Lock.
    - c. Concealed Overhead Closer with Stop and Hold Open.
    - d. Door Pull handle.
    - e. Exit Device. Trapeze style not acceptable
  - 2) Power Door Operator and Actuators: As Specified in Section 08 71 13.
  - 3) Other Door Hardware: As specified in Section 08 71 00.
    - a. Keyed Cylinder.
- B. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.
- C. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.
- D. Interior Vestibule Doors: Each door to include: weatherstripping and sill sweep strip.
  - 1) Continuous Hinge.
  - 2) Door Pull handle and push bar.
  - 3) Concealed Overhead Closer with Stop and Hold Open.
- E. Power Door Operator and Actuators: As Specified in Section 08 71 13.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.
- C. Notification: Notify General Contractor of unsatisfactory conditions in writing with copy to Architect.

### **3.02 INSTALLATION**

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

- I. Install hardware using templates provided.
  - 1) See Section 08 71 00 for hardware installation requirements.
- J. Install glass in accordance with Section 08 80 00, using glazing method required to achieve performance criteria.
- K. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

### **3.03 TOLERANCES**

- A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 1/16 inches per 10 ft, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

### **3.04 ADJUSTING**

- A. Adjust operating hardware and sash for smooth operation.

### **3.05 CLEANING**

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

### **3.06 PROTECTION**

- A. Protect installed products from damage until Date of Substantial Completion.

**END OF SECTION**

## **SECTION 08 71 00 DOOR HARDWARE**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Hardware for wood, aluminum, and hollow metal doors.
- B. Hardware for fire-rated doors.
- C. Thresholds.
- D. Cylinders for doors specified in other Sections.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 08 11 13 - Hollow Metal Doors and Frames.
- B. Section 08 14 16 - Flush Wood Doors.
- C. Section 08 33 23 - Overhead Coiling Doors: Lockable coiling doors.
- D. Section 08 43 13 - Aluminum-Framed Storefronts: Hardware for doors in storefront, including:
  - 1) Integral weatherstripping.
  - 2) Hinges.
  - 3) Exit devices.
  - 4) Closers.
  - 5) Push bars and pull handles.
  - 6) Installation of lock cylinders provided under this section.

#### **1.03 REFERENCE STANDARDS**

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- C. BHMA A156.3 - American National Standard for Exit Devices; 2014.
- D. BHMA A156.4 - American National Standard for Door Controls - Closers; 2013.
- E. BHMA A156.13 - American National Standard for Mortise Locks & Latches Series 1000; 2012.
- F. BHMA A156.21 - American National Standard for Thresholds; 2014.
- G. BHMA A156.22 - American National Standard for Door Gasketing and Edge Seal Systems, Builders Hardware Manufacturers Association; 2012.
- H. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2016.
- I. UL (DIR) - Online Certifications Directory; current listings at [database.ul.com](http://database.ul.com).

#### **1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware will be installed upon.
- B. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
  - 1) Templates to be furnished within 10 days after receipt of accepted hardware schedule.
- C. Convey UCCS's keying requirements to manufacturers.

- D. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; require attendance by all affected installers.
- E. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

#### 1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project.
- C. Hardware Schedule: Detailed listing of each item of hardware to be installed on each door. Use door numbering scheme as included in the Contract Documents. Identify electrically operated items and include power requirements.
- D. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:
  - 1) Vertical format, horizontal format will not be reviewed and will be returned marked "not approved".
  - 2) Type, style, function, size, and finish of each hardware item.
  - 3) Maximum allowable degree of swing and door handing.
  - 4) Fire rating.
  - 5) Name and manufacturer of each item.
  - 6) Fastenings and other pertinent information.
  - 7) Location of each hardware set cross-referenced to indications on Drawings both on floor plans and in door and frame schedule.
  - 8) Explanation of all abbreviations, symbols, and codes contained in schedule.
  - 9) Mounting locations for hardware.
  - 10) Door and frame sizes and materials.
  - 11) Description of electrified door hardware sequences of operation and interfaces with other building control systems.
- E. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.
- F. As well as any other pertinent information regarding door and quality and type of hardware to be furnished.
- G. Keying Schedule: Submit for approval of UCCS.
  - 1) Submit within 20 days of receipt of order for finish hardware.
- H. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
  - 1) Submit manufacturer's parts lists and templates.
  - 2) Bitting List: List of combinations as furnished.
- I. Keys: Deliver with identifying tags to UCCS by security shipment direct from hardware supplier.
- J. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in UCCS's name and registered with manufacturer.
- K. Maintenance Materials and Tools: Furnish the following for UCCS's use in maintenance of project.
  - 1) See Section 01 60 00 - 01 60 00, for additional provisions.



- 2) Tools: One set of all special wrenches or tools applicable to each different or special hardware component, whether supplied by the hardware component manufacturer or not.

#### **1.06 QUALITY ASSURANCE**

- A. Fire-Rated Openings: Provide door hardware for fire-rated openings that complies with NFPA Standard No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by UL, Warnock Hersey, FM, or other testing and inspecting organization acceptable to authorities having jurisdiction for use on types and sizes of doors indicated in compliance with requirements of fire-rated door and door frame labels.
- B. Hardware Supplier Qualifications: Company specializing in supplying the type of products specified in this section with at least three years documented experience .
- C. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC) to assist in the work of this section.
- D. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.
- E. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.
- F. E. 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.
- G. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines ICC/ANSI A117.1.
  - 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 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Package hardware items individually; label and identify each package with door opening code to match hardware schedule.

#### **1.08 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Warranty Period: Two years from date of Substantial Completion, unless otherwise indicated.
  - 1) Locksets: 5 years from date of substantial Completion.
  - 2) Exit Devices: 5 years from date of Substantial Completion.

- 3) Manual Closers: 10 years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.01 DOOR HARDWARE - GENERAL**

- A. Provide hardware specified or required to make doors fully functional, compliant with applicable codes, and secure to the extent indicated.
- B. Provide items of a single type of the same model by the same manufacturer.
- C. Provide products that comply with the following:
  - 1) Applicable provisions of federal, state, and local codes.
  - 2) Fire-Rated Doors: NFPA 80.
  - 3) Hardware on Fire-Rated Doors , Except Hinges: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.
  - 4) Hardware for Smoke and Draft Control Doors (Indicated as "S" on Drawings): Provide hardware that enables door assembly to comply with air leakage requirements of the applicable code.

### **2.02 LOCKS AND LATCHES**

- A. Locks: Provide a lock for every door, unless specifically indicated as not requiring locking.
  - 1) If no hardware set is indicated for a swinging door provide an office lockset.
  - 2) Trim: Provide lever handle or pull trim on outside of all locks unless specifically stated to have no outside trim.
  - 3) Lock Cylinders: Provide key access on outside of all locks unless specifically stated to have no locking or no outside trim.
- B. Electrically Operated Locks: Fail secure unless otherwise indicated.
- C. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with ANSI A117.1. FED-STD-795, "Uniform Federal Accessibility Standards."
  - 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.
- D. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
- E. Lock Trim:
  - 1) Levers: Cast, plated to finish specified.
  - 2) Escutcheons: Wrought
  - 3) Lockset Designs: Provide design indicated.
- F. 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.
- G. Backset: 2-3/4 inches.
- H. Strikes: Manufacturer's standard strike with strike box for each latch bolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:
  - 1) Strikes for Locks and Latches: BHMA A156.2.
- I. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:
- J. BHMA standards in three paragraphs below are used as basis for comparing products even if manufacturers' products are named in door hardware sets. Delete grade

options if grade is indicated in door hardware sets. Insert function requirements with each set if an allowance is used to specify door hardware.

- K. Bored Locks: BHMA A156.2, Grade 1; Series 4000
  - 1) Coordinate subparagraph and list below with Part 2 "Scheduled Door Hardware" Article. Retain "Available" for nonproprietary and delete for semiproprietary specifications.
  - 2) Required Manufacturer:
    - a. Schlage Lock Company: an Allegion Group Co. (ND Series)
- L. Latches: Provide a latch for every door that is not required to lock, unless specifically indicated "push/pull" or "not required to latch".

### 2.03 LOCK CYLINDERS

- A. Cylinders: BHMA A156.5, Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
  - 1) First option in subparagraph below is not available for high-security cylinders.
  - 2) Number of Pins: Seven.

### 2.04 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:
  - 1) Existing Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key. Coordinate with UCCS for keyways required to match existing.
- B. Keys: Nickel silver.
  - 1) Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
    - a. Notation: "DO NOT DUPLICATE."
  - 2) Quantity: Provide the following:
    - a. Cylinder Change Keys: Three.
    - b. Top Master Key: One.
    - c. Master Keys: Five.
    - d. Grand Mater Keys: Five.
    - e. Construction Control Keys: Ten.
- C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
  - 1) Removable Cores: Core insert, removable by use of a special key.
- D. Keys: Nickel silver.
  - 1) Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
    - a. Notation: "DO NOT DUPLICATE."
  - 2) Quantity: Provide the following:
    - a. Cylinder Change Keys: Three.
    - b. Master Keys: Five.
    - c. Grand Mater Keys: Five
    - d. Control Keys: Two
- E. Construction Keying: Comply with the following:
  - 1) Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 5 construction master keys, 2 construction control keys.
  - 2) Replace construction cores with permanent cores as directed by Owner.
- F. Acceptable Required Manufacturer:

- 1) Medeco X4; an Assa Abloy Group Company.

## **2.05 HINGES**

- A. Hinges: Provide hinges on every swinging door.
  - 1) Provide five-knuckle full mortise butt hinges unless otherwise indicated.
  - 2) Provide ball-bearing hinges at all doors having closers.
  - 3) Provide hinges in the quantities indicated.
  - 4) Provide non-removable pins on exterior outswinging doors.
  - 5) Where electrified hardware is mounted in door leaf, provide power transfer hinges.
- B. Butts and Hinges: BHMA A156.1. Five knuckle design.
- C. Template Hinge Dimensions: BHMA A156.7.
- D. Available Manufacturers:
  - 1) Bommer Industries. BB5000 Series
  - 2) Ives Hardware. 5BB1, 5BB1HW Series
  - 3) Stanley Commercial Hardware; Div. of the Stanley Works. FBB Series

## **2.06 MORTISE LOCKSETS**

- A. Locking Functions: As defined in BHMA A156.13, and as follows:
- B. Manufacturers - Mortise Locksets:
  - 1) Assa Abloy Brands; Corbin Russwin.

## **2.07 FLUSHBOLTS**

- A. Manual-Extension Flush Bolts: BHMA A156.16, Grade 1, fabricated from extruded brass or bronze, with 12-inch (305-mm) rod, unless otherwise indicated or required by door height, actuated by flat lever; listed and labeled for fire-rated doors. Provide with matching dustproof strike, omit at doors with threshold.
  - 1) Available Manufacturers:
    - a. Architectural Builders Hardware Mfg., Inc.
    - b. Burns Manufacturing Incorporated.
    - c. Don-Jo Mfg., Inc.
    - d. IVES Hardware; an Allegion Group Company.
    - e. Rockwood Manufacturing Company.
    - f. Trimco.

## **2.08 EXIT DEVICES**

- A. Locking Functions: Functions as defined in BHMA A156.3, and as follows:
- B. Manufacturers - Exit Devices:
  - 1) Von Duprin, an Allegion brand .

## **2.09 CLOSERS**

- A. Closers: Complying with BHMA A156.4.
  - 1) Provide surface-mounted, door-mounted closers unless otherwise indicated.
  - 2) Provide a door closer on every exterior door.
  - 3) Provide a door closer on every fire- and smoke-rated door. Spring hinges are not an acceptable self-closing device unless specifically so indicated.
  - 4) On pairs of swinging doors, if an overlapping astragal is present, provide coordinator to ensure the leaves close in proper order.
- B. Manufacturers - Surface Mounted Closers:
  - 1) LCN, an Allegion brand ; (4040XP Series).

## **2.10 STOPS AND HOLDERS**

- A. Stops and Bumpers: BHMA A156.16, Grade 1 unless Grade 2 is indicated.

- B. Provide floor stops for doors unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead stops.
- C. Combination Overhead Stops and Holders: BHMA A156.8, Grade 1 unless Grade 2 is indicated.
- D. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch; fabricated for drilled-in application to frame.
- E. Manufacturers:
  - 1) Architectural Builders Hardware Mfg., Inc.
  - 2) Burns Manufacturing Incorporated.
  - 3) Don-Jo Mfg., Inc.
  - 4) IVES Hardware; an Allegion Group Company.
  - 5) Rockwood Manufacturing Company.
  - 6) Trimco.

## 2.11 GASKETING AND THRESHOLDS

- A. Gaskets: Complying with BHMA A156.22.
  - 1) On each door in smoke partition, provide smoke gaskets; top, sides, and meeting stile of pairs. If fire/smoke partitions are not indicated on drawings, provide smoke gaskets on each door identified as a "smoke door" and 20-minute rated fire doors.
  - 2) On each exterior door, provide weatherstripping gaskets, unless otherwise indicated; top, sides, and meeting stiles of pairs.
    - a. Where exterior door is also required to have fire or smoke rating, provide gaskets functioning as both smoke and weather seals.
  - 3) On each exterior door, provide door bottom sweep, unless otherwise indicated.
- B. Thresholds: Complying with BHMA A156.21.
  - 1) At each exterior door, provide a threshold unless otherwise indicated.
  - 2) Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with ANSI A117.1.
    - a. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
  - 3) Provide stainless steel fasteners and lead shields for all thresholds.
  - 4) Available Manufacturers:
    - a. National Guard Products.
    - b. Pemko Manufacturing
    - c. Reese Enterprises.

## 2.12 PROTECTION PLATES AND ARCHITECTURAL TRIM

- A. Protection Plates:
  - 1) Kickplate: Provide on push side of every door with closer, except aluminum storefront and glass entry doors.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that doors and frames are ready to receive work; labeled, fire-rated doors and frames are present and properly installed, and dimensions are as indicated on shop drawings.

### 3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Use templates provided by hardware item manufacturer.

- C. Install hardware on fire-rated doors and frames in accordance with code and NFPA 80.
- D. Mounting Heights: Mount door hardware units at to comply with the following unless otherwise indicated or required to comply with governing regulations.
  - 1) Standard Steel Doors and Frames: ANSI/SDI A250.8.
- E. Set exterior door thresholds with full-width bead of elastomeric sealant on each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.

**3.03 ADJUSTING**

- A. Adjust work under provisions of Section 01 70 00.
- B. Adjust hardware for smooth operation.

**3.04 CLEANING**

**3.05 PROTECTION**

- A. Protect finished Work under provisions of Section 01 70 00.
- B. Do not permit adjacent work to damage hardware or finish.

**3.06 SCHEDULE**

**Manufacturer List:**

<u>Code</u>	<u>Name</u>
AB	ABH Manufacturing Inc.
BY	By Others
CR	Corbin Russwin
DJ	Don-Jo
IV	Ives
LC	LCN Closers
LO	Schlage Electronics
ME	Medeco
NA	National Guard
SC	Schlage
SE	Security Door Controls
SP	Special Lite
TR	Trimco
VO	Von Duprin

**Option List**

<u>Code</u>	<u>Description</u>
LC	LESS STANDARD CYLINDERS-DBL
RX	REQUEST TO EXIT
CON	Molex Connectors
DEL	DELAYED ACTION
LBR	LESS BOTTOM ROD
NRP	Non Removable Pin
QEL	Quiet Electric Latch Retraction
SRT	Self-Reaming, Self-Tapping Wd/Hm Screw
TW8	Elec.Thru-Wire, (BR/SS) 8 Wire
RX-2	REQUEST TO EXIT - Double Switch
10-025	STRIKE-ANSI, 1 3/4" DRS., 1 1/4" X 4 7/8
900-4RL	4 Relay Board Output Integrated Logic
SSMS/LA	STAINLESS MACHINE SCREWS/LEAD ANCHOR

425-SNB SEX BOLTS

### Finish List

<u>Code</u>	<u>Description</u>
26	Satin Chrome
AL	Aluminum
CP	Chrome Plated
626	Satin Chromium Plated
628	Satin Aluminum, Clear Anodized
630	Satin Stainless Steel
GREY	Grey
SP28	Lacquer Sprayed Aluminum
US26D	Chromium Plated, Dull
US32D	Stainless Steel, Dull

### Hardware Sets

#### SET #1

6 Hinges	5BB1 4 1/2 x 4 1/2 NRP	630	IV
2 Elec. Hinges	5BB1 4 1/2 x 4 1/2 CON TW8	630	IV
1 Exit Device	OEL RX 99NL x 990NL-R&V 425-SNB CON	US26D	VO
1 Exit Device	RX 99EO x 990EO 425-SNB (QTY-2) CON	US26D	VO
1 Rim Cylinder	80-159	626	SC
1 Mortise Cylinder	80-132	626	SC
2 SFIC Core	33N700006	26	ME
2 Closer   S/Stop	4040 XP SCUSH SRT	AL	LC
2 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
2 Door Cord	798C-18		LO
1 Set Weatherstrip	703 EV (HEAD & JAMBS) PR		NA
1 Mullion Seal	5100 S		NA
2 Door Sweep	200 NA		NA
1 Saddle Threshold	425 E x SSMS/LA (PR)	AL	NA
2 Set Plug Connectors	AS REQ'D		LO
1 Card Reader	CARD READER BY OWNER'S SECURITY		BY

NOTE: Existing Mullion - Remain in-place. Mount new strikes at existing location.  
Mount Electric Hinge at exit device. Face bore to hinge pad and prep as required.

#### SET #2

8 Hinges	5BB1 4 1/2 x 4 1/2 NRP	630	IV
1 Mullion	KR4954	SP28	VO
1 Exit Device	99NL x 990NL-R&V 425-SNB (QTY-2)	US26D	VO
1 Exit Device	99EO x 990EO 425-SNB (QTY-2)	US26D	VO
1 Rim Cylinder	80-159	626	SC
1 Mortise Cylinder	80-132	626	SC
2 SFIC Core	33N700006	26	ME
2 Closer   S/Stop   HO	4040 XP SHCUSH SRT	AL	LC
2 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Set Weatherstrip	703 EV (HEAD & JAMBS) PR		NA
1 Mullion Seal	5100 S		NA
2 Door Sweep	200 NA		NA
1 Saddle Threshold	425 E x SSMS/LA (PR)	AL	NA

**SET #3**

8 Hinges	5BB1 4 1/2 x 4 1/2 NRP	630	IV
2 Flush Bolt	3917-12ET (1/24" x 1/12")	626	TR
1 DB Entry Lockset	L9453HD 06A	626	SC
1 SFIC Core	33N700006	26	ME
2 Closer   S/Stop	4040 XP SCUSH SRT	AL	LC
2 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Set Weatherstrip	703 EV (HEAD & JAMBS) PR		NA
1 Astragal	148 NA		NA
1 Drip Cap	16 A - 4" ODW		NA
2 Door Sweep	200 NA		NA
1 Saddle Threshold	425 E x SSMS/LA (PR)	AL	NA

**SET #4**

4 Hinges	5BB1 4 1/2 x 4 1/2 NRP	630	IV
1 DB Storeroom Lockset	L9480HD 06A	626	SC
1 SFIC Core	33N700006	26	ME
1 Closer   S/Stop	4040 XP SCUSH SRT	AL	LC
1 Set Weatherstrip	703 EV (HEAD & JAMBS)		NA
1 Drip Cap	16 A - 4" ODW		NA
1 Door Sweep	200 NA		NA
1 Saddle Threshold	425 E 36" 10-24 SSMS/LA	AL	NA

**SET #5**

6 Hinges	5BB1 4 1/2 x 4 1/2 NRP	630	IV
2 Elec. Hinges	5BB1 4 1/2 x 4 1/2 CON TW8	630	IV
1 Mullion	KR4954	SP28	VO
1 Exit Device	OEL RX 99NL x 990NL-R&V 425-SNB CON	US26D	VO
1 Exit Device	RX 99EO x 990EO 425-SNB (QTY-2) CON	US26D	VO
1 Rim Cylinder	80-159	626	SC
1 Mortise Cylinder	80-132	626	SC
2 SFIC Core	33N700006	26	ME
2 Closer   S/Stop	4040 XP SCUSH SRT	AL	LC
2 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
2 Door Cord	798C-18		LO
1 Set Weatherstrip	703 EV (HEAD & JAMBS) PR		NA
1 Mullion Seal	5100 S		NA
2 Door Sweep	200 NA		NA
1 Saddle Threshold	425 E x SSMS/LA (PR)	AL	NA
2 Set Plug Connectors	AS REQ'D		LO
1 Card Reader	CARD READER BY OWNER'S SECURITY		BY

NOTE: Mount Electric Hinge at exit device. Face bore to hinge pad and prep as required.



**SET #6**

8 Hinges	5BB1 4 1/2 x 4 1/2 NRP	630	IV
1 Mullion	KR4954	SP28	VO
1 Exit Device	99EO x 996EO-R&V 425-SNB (QTY-2)	US26D	VO
1 Exit Device	99L x 996L-R&V 425-SNB (QTY-2)	US26D	VO
1 Mortise Cylinder	80-132	626	SC
1 Rim Cylinder	80-159	626	SC
2 SFIC Core	33N700006	26	ME
2 Closer   S/Stop	4040 XP SCUSH SRT	AL	LC
2 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Set Weatherstrip	703 EV (HEAD & JAMBS) PR		NA
1 Mullion Seal	5100 S		NA
1 Drip Cap	16 A - 4" ODW		NA
2 Door Bottom	35 VA		NA
1 Saddle Threshold	427 E 72"	AL	NA

**SET #7**

3 Hinges	5BB1 4 1/2 x 4 1/2 NRP	630	IV
1 Exit Device	99L x 996L-R&V 425-SNB (QTY-2)	US26D	VO
1 Rim Cylinder	80-159	626	SC
1 SFIC Core	33N700006	26	ME
1 Closer   S/Stop   HO	4040 XP SHCUSH SRT	AL	LC
1 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Drip Cap	16 A - 4" ODW		NA
1 Solid Weatherstrip	9700 A (HEAD & JAMBS)		NA
1 Door Sweep	200 NA		NA
1 Saddle Threshold	425 E 36" 10-24 SSMS/LA	AL	NA

NOTE: Re-Work existing jamb for strike area. Install W/S to mount new exit device strike.

Adjust template location.

**SET #8**

8 Hinges	5BB1 4 1/2 x 4 1/2 NRP	630	IV
2 Flush Bolt	3917-12ET (1/24" x 1/12")	626	TR
1 Lockset	ML2022 NSA LC SS078	626	CR
2 Mortise Cylinder	80-132 x B520-253	626	SC
2 SFIC Core	33N700006	26	ME
2 Closer   S/Stop   HO	4040 XP SHCUSH SRT	AL	LC
1 Set Weatherstrip	703 EV (HEAD & JAMBS) PR		NA
1 Astragal	148 NA		NA
1 Drip Cap	16 A - 4" ODW		NA
1 Saddle Threshold	893 S x SSMS/LA (PR)	AL	NA

NOTE: Lockset specified for direct replacement to existing door.

Coordinate new Hardware with existing conditions. Re-Work as required

Verify Door undercut for Threshold prior to order.

**SET #9**

1	Continuous Hinge	BY SECTION 08 43 13		
1	Exit Device	BY SECTION 08 43 13		
1	Rim Cylinder	80-159	626	SC
1	Mortise Cylinder	80-132	626	SC
3	SFIC Core	33N700006	26	ME
1	Low Energy Operator	BY SECTION 08 71 13		BY
2	Concealed Overhead Closer with Stop/Holder	BY SECTION 08 43 13		
1	Key Switch	705 L2	630	SE
1	Power Supply	PS902 900-4RL		VO
2	Power Transfer	EPT 10	SP28	VO
2	Door Pull	BY SECTION 08 43 13		
1	Removable Mullion	KR-SL60	628	SP
1	Mortise Cylinder	80-133	626	SC
2	Door Sweep	BY SECTION 08 43 13		
1	Saddle Threshold	424 E x SSMS/LA	AL	NA
1	Weatherseals	BY SECTION 08 43 13		
2	Set Plug Connectors	AS REQ'D		LO
1	Card Reader	CARD READER BY OWNER'S SECURITY		BY

**SET #10**

1	Padlock	KS21D1200		SC
1	SFIC Core	33N700006	26	ME

NOTE: All remaining Hardware by Door Manufacturer

**SET #11**

1	SFIC Core	33N700006	26	ME
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NOTE: All remaining Hardware existing to remain in-place

**SET #12**

NOTE: All Hardware existing to remain in-place

**SET #100**

2	Continuous Hinges	BY SECTION 08 43 13		
1	Low Energy Operator	BY SECTION 08 71 13		BY
1	Concealed Overhead Closer with Stop/Holder	BY SECTION 08 43 13		
2	Door Pull	BY SECTION 08 43 13		
2	Sill Sweep	BY SECTION 08 43 13		
1	Weatherseals	BY SECTION 08 43 13		

**SET #101**

3 Hinges	5BB1 4 1/2 x 4 1/2	626	IV
1 Office Lockset	ND53BDC RHO 10-025	626	SC
1 SFIC Core	33N700006	26	ME
1 Closer	4040 XP REG	AL	LC
1 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Floor Stop	1211	626	TR
1 Edge Filler Plate	CV-86	CP	DJ
2 Modernizing Plate	RP-13509-2	630	DJ
1 Gasketing	5040 B (HEAD & JAMBS)		NA

NOTE: Remove all existing Hardware - Re-prep for new Hardware - Patch and fill as required

**SET #102**

3 Hinges	5BB1 4 1/2 x 4 1/2	626	IV
1 Storeroom Lockset	ND80BDC RHO 10-025	626	SC
1 SFIC Core	33N700006	26	ME
1 Closer	4040 XP REG	AL	LC
1 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Floor Stop	1211	626	TR
1 Edge Filler Plate	CV-86	CP	DJ
2 Modernizing Plate	RP-13509-2	630	DJ
1 Gasketing	5040 B (HEAD & JAMBS)		NA

NOTE: Remove all existing Hardware - Re-prep for new Hardware - Patch and fill as required

**SET #103**

3 Hinges	5BB1 4 1/2 x 4 1/2 NRP	626	IV
1 Office Lockset	ND53BDC RHO 10-025	626	SC
1 SFIC Core	33N700006	26	ME
1 Closer	4040 XP EDA SRT	AL	LC
1 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Wall Bumper	1270WV	630	TR
1 Edge Filler Plate	CV-86	CP	DJ
1 Modernizing Plate	RP-13509-2	630	DJ
1 Gasketing	5040 B (HEAD & JAMBS)		NA

NOTE: Remove all existing Hardware - Re-prep for new Hardware - Patch and fill as required

**SET #104**

3 Hinges	5BB1 4 1/2 x 4 1/2 NRP	626	IV
1 Office Lockset	ND53BDC RHO 10-025	626	SC
1 SFIC Core	33N700006	26	ME
1 Closer	4040 XP EDA SRT	AL	LC
1 Wall Bumper	1270WV	630	TR
1 Edge Filler Plate	CV-86	CP	DJ
1 Modernizing Plate	RP-13509-2	630	DJ
1 Brush Sweep	600 A		NA
1 Gasketing	5040 B (HEAD & JAMBS)		NA

**SET #105**

6 Hinges	5BB1 4 1/2 x 4 1/2 NRP	626	IV
2 Flush Bolt	3917-12	626	TR
1 Storeroom Lockset	ND80BDC RHO 10-025	626	SC
1 SFIC Core	33N700006	26	ME
2 Wall Bumper	1270WV	630	TR
1 Dustproof Strike	3910	630	TR
1 Astragal	148 NA		NA
1 Gasketing	5040 B (HEAD & JAMBS)		NA

**SET #106**

3 Hinges	5BB1 4 1/2 x 4 1/2	626	IV
1 Storeroom Lockset	ND80BDC RHO 10-025	626	SC
1 SFIC Core	33N700006	26	ME
1 Closer	4040 XP REG	AL	LC
1 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Wall Bumper	1270WV	630	TR
1 Gasketing	5040 B (HEAD & JAMBS)		NA

**SET #107**

3 Hinges	5BB1 4 1/2 x 4 1/2 NRP	626	IV
1 Fire Exit Device	99NL-F x 990NL-R&V 425-SNB (QTY-2)	US26D	VO
1 Rim Cylinder	80-159	626	SC
1 SFIC Core	33N700006	26	ME
1 Closer	4040 XP EDA SRT	AL	LC
1 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Wall Bumper	1270WV	630	TR
1 Gasketing	5040 B (HEAD & JAMBS)		NA

**SET #108**

6 Hinges	5BB1 4 1/2 x 4 1/2 NRP	626	IV
1 Exit Device	9927EO x 996EO-R&V 425-SNB (QTY-2) LBR	US26D	VO
1 Exit Device	9927L x 996L-R&V 425-SNB (QTY-2) LBR	US26D	VO
1 Rim Cylinder	80-159	626	SC
1 SFIC Core	33N700006	26	ME
2 Closer	4040 XP EDA SRT	AL	LC
2 Kick Plate	K0050 10" x 1" LDW CSK	630	TR
2 Wall Bumper	1270WV	630	TR
2 Door Silencers	1229A	GREY	TR

**SET #109**

3 Hinges	5BB1 4 1/2 x 4 1/2	626	IV
1 Clsrn Lockset	ND70BDC RHO 10-025	626	SC
1 SFIC Core	33N700006	26	ME
1 Closer	4040 XP REG DEL SRT	AL	LC
1 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Wall Bumper	1270WV	630	TR
1 Gasketing	5040 B (HEAD & JAMBS)		NA

**SET #110**

3 Hinges	5BB1 4 1/2 x 4 1/2	626	IV
1 Privacy Set	ND40S RHO 10-025	626	SC
1 Closer	4040 XP REG DEL SRT	AL	LC
1 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Floor Stop	1211 (DR-105)	626	TR
1 Wall Bumper	1270WV	630	TR
1 Gasketing	5040 B (HEAD & JAMBS)		NA

**SET #111**

3 Hinges	5BB1 4 1/2 x 4 1/2	626	IV
1 Storeroom Lockset	ND80BDC RHO 10-025	626	SC
1 SFIC Core	33N700006	26	ME
1 Closer	4040 XP REG DEL SRT	AL	LC
1 Kick Plate	K0050 10" x 2" LDW CSK	630	TR
1 Floor Stop	1211	626	TR
1 Gasketing	5040 B (HEAD & JAMBS)		NA

**SET #112 - Existing. Doors**

NOTE: All Hardware existing to remain in-place

**END OF SECTION**



## **SECTION 08 71 13**

### **POWER DOOR OPERATORS**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Operators for doors provided in other sections.
- B. Controllers, actuators and safety devices.
- C. Maintenance.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 08 43 13 - Aluminum-Framed Storefronts.
- B. Division 26 for electrical connections including conduit and wiring for power door operators.

##### **1.03 REFERENCE STANDARDS**

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ANSI A156.19: For Power Assist and Low Energy Power Operated Doors.
- C. ICC A117.1 - Accessible and Usable Buildings and Facilities; International Code Council; 2009 (ANSI).
- D. BHMA A156.10 - American National Standard for Power Operated Pedestrian Doors; Builders Hardware Manufacturers Association; 2011 (ANSI/BHMA A156.10).
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL (ECMD) - Electrical Construction Materials Directory; Underwriters Laboratories Inc.; current edition.
- G. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

##### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
  - 1) Indicate layout and dimensions; head, jamb, and sill conditions; elevations; components, anchorage, recesses, materials, and finishes, electrical characteristics and connection requirements.
  - 2) Identify installation tolerances required, assembly conditions, routing of service lines and conduit, and locations of operating components and boxes.
- C. Product Data: Provide data on system components, sizes, features, and finishes.
- D. Maintenance Data: Include manufacturer's parts list and maintenance instructions for each type of hardware and operating component.
- E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in UCCS's name and registered with manufacturer.
- F. Maintenance Materials: Furnish the following for UCCS's use in maintenance of project.
  - 1) See Section 01 60 00 - 01 60 00, for additional provisions.
  - 2) Wrenches and other tools required for maintenance of equipment.

## **1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum five (5) years of experience.

## **1.06 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide two year manufacturer warranty.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Door Operators for Swing Doors Specified in Other Sections:
  - 1) ASSA ABLOY Entrance Solutions.
  - 2) LCN, an Allegion brand; 2800 Series (Bottom Load).
  - 3) Horton Automatics; HD Swing 4000 Series (Bottom Load).
  - 4) Stanley; Magic Force (Bottom Load).
  - 5) Substitutions: Not permitted.

### **2.02 OPERATORS FOR SWINGING DOORS PROVIDED BY OTHERS**

- A. Door Operator: Electric, surface mounted overhead.
  - 1) Operation: Low-energy power open, spring close operation.
  - 2) Variable speed control for opening and closing cycles.
- B. Operator: The Electric Operating Mechanism shall be mounted and concealed in an extruded aluminum case for smooth and quiet operation. Maximum current draw shall not exceed 3.15 amps.
  - 1) Opening Action: Shall be accomplished by a 1/15 HP D.C. permanent magnet motor working through reduction gears to the output shaft.
    - a. Field Adjustable Spring Closing Action: shall be accomplished by a field replaceable spring. When the door is in the closing mode or fully closed, motor voltage shall not be required and will be off. The door can be manually operated with power on or off without damage to the operator.
    - b. Independent Adjustable Closing and Latching Speed Control: The operator shall employ a rheostat module to allow for independent field adjustment of closing and latching speeds using the motor as a dynamic brake.
    - c. Field Adjustable Open Stop: The operator shall provide a field adjustable open stop to accommodate opening angles from 80 to 135 degrees without the need for additional components.
    - d. Consistent Cycle: The operator shall deliver an even, consistent open force across the entire transition from door fully closed to door open check. Additionally, the range of the force shall be field adjustable to accommodate a wide range of on-site conditions.
    - e. Manual Use: The operator shall function as a manual door closer in the direction of swing with or without electrical power. The operator shall deliver an even, consistent open force across the entire transition from door fully closed to door fully open.
  - 2) Control Switch: Automatic door operators shall be equipped with a three position function switch to control the operation of the door. Control switch shall provide three modes of operation, Automatic, Off, and Hold-Open.
  - 3) Master Control: Shall incorporate the following features:



- a. Adjustable time delay of 2 to 30 seconds (ANSI A156.19 requirement is 5 second minimum time delay).
  - 1) Infinite adjustment to opening and open check speeds including adjusting the opening force without affecting the opening speed.
  - 2) Immediate reversal of door motion without undue strain on the drive train. This will be accomplished by supplying stepped voltage to the motor. The door shall reverse when closing if an object stops the door.
  - 3) Motor Protection Circuit: A locked door motor protection circuit will be supplied that will shut off current to the motor when the door is inadvertently locked or otherwise prevented from opening.
- 4) Enclosure: Enclosure to be finished to match adjacent door system framing.

### **2.03 CONTROLLERS, ACTUATORS, AND SAFETIES**

- A. Controller: Provide microprocessor operated controller for each door.
- B. Comply with BHMA A156.10 for actuator and safety types and zones, and ANSI A156.19, UL 325, and UL 1998.
- C. Controller Protection: The controller shall incorporate the following features to ensure trouble free operation:
  - 1) Automatic Reset upon power up.
  - 2) Main fuse protection.
  - 3) Electronic surge protection.
  - 4) Internal power supply protection.
  - 5) Resettable sensor supply fuse protection.
- D. Push Button Interface: The controller shall have push button switches with to allow for selection or change of the following parameters: carpet or timer logic, single or dual door, activation options, normal back check or large back check, push-to-open assist on/off.
- E. Soft Start/Stop: A "soft-start" "soft-stop" motor driving circuit shall be provided for smooth normal opening and recycling.
- F. Actuators to be provided on each side of openings where indicated on Contract Drawings and complying with ANSI Safety Standard A117.1. Actuators to be hardwired to door operator controls.
- G. Actuating device shall be momentary contact microswitch assembly in a push plate: 4-1/2" square, stainless steel switch. Engravings and plate finish to be selected from manufacturer's full range of engravings and finishes.
- H. Mounting of actuation device: Wall mounted.
- I. Push Button Actuator: Standard momentary contact type, wall mounted, recessed; stainless steel escutcheon plate.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that surfaces are ready to receive work and dimensions are as indicated on shop drawings.
- B. Verify that electric power is available and is of the correct characteristics.

### **3.02 INSTALLATION**

- A. Install equipment in accordance with manufacturer's instructions.
- B. Coordinate installation of components with related and adjacent work; level and plumb.

### **3.03 ADJUSTING**

- A. Adjust door equipment for correct function and smooth operation.

### **3.04 CLEANING**

- A. Remove temporary protection, clean exposed surfaces.
- B. Repair or replace damaged installed products.
- C. Clean product surfaces and lubricate operating equipment for optimum condition and safety.

### **3.05 CLOSEOUT ACTIVITIES**

- A. Provide O&M manuals per 01 78 00, Closeout Submittals.
- B. Demonstrate operation, operating components, adjustment features, and lubrication requirements.
  - 1) See Section 01 79 00, Demonstration and Training for maintenance training.

**END OF SECTION**

## **SECTION 08 80 00 GLAZING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Glass.
- B. Glazing compounds and accessories.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 07 92 00 - Joint Sealants: Sealants for other than glazing purposes.
- B. Section 08 43 13 - Aluminum-Framed Storefronts: Glazing furnished for storefront system.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014.
- B. ASTM C1036 - Standard Specification for Flat Glass; 2011.
- C. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2012.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2013.
- E. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2012a.
- F. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2010.
- G. GANA (\$M) - GANA Sealant Manual; 2008.
- H. ICC (IBC) - International Building Code; 2015.
- I. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use; 1990 (2004).

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
- C. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors.
- D. Samples: Submit two samples 12"x12" inch in size of glass units, showing coloration.

#### **1.05 QUALITY ASSURANCE**

- A. Insulated Glass: Units shall be double sealed, single seal is not acceptable. Insulated glass units shall meet performance requirements of ASTM E774 (Class CBA). Insulating glass units shall be manufactured by member of Insulating Glass Certification Council (IGCC) or Sealed Insulating Glass Manufacturing Association (SIGMA).
- B. Safety Glass and Glazing: Comply with State Statues, IBC 2009 and ANSI Z97.1.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum five (5) years experience.

#### **1.06 DELIVERY, STORAGE AND HANDLING**

- A. Delivery: Schedule delivery to coincide with glazing schedules so minimal handling of glazing is required.

- B. Storage: Store glazing according to manufacturer's / supplier's printed instructions and as specified in Section 01 60 00. Store in areas least subject to traffic or falling objects. Keep storage area clean and dry. Stack individual glazing panels on edge, leaned slightly against upright supports with separators between each panel.

### **1.07 FIELD CONDITIONS**

- A. Field Measurements: Field measure openings before ordering tempered glass products. Be responsible for proper fit of field measured products.
- B. Do not install glazing when ambient temperature is less than 50 degrees F.
- C. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.
- D. Breakage: Contractor is responsible for all glass broken during shipment, storage and installation.

### **1.08 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Sealed Insulating Glass Units: Provide a ten (10) year warranty to include coverage for seal failure, interpane dusting or misting, including replacement of failed units.

## **PART 2 PRODUCTS**

### **2.01 INSULATING GLASS UNITS**

- A. Type GL1 - Sealed Insulating Glass Units: Vision glass, double glazed.
  - 1) Application: Exterior glazing for storefront system at human impact areas and where required by code, exterior windows, exterior storefront doors, or indicated on Contract Drawings.
  - 2) 1/2 inch air space.
  - 3) Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
    - a. Tint: Bronze to match north building.
    - b. Coating: Low-E (solar control type), on #2 surface.
  - 4) Inboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
    - a. Tint: Clear.
  - 5) Glass bears IGCC certification numbers
  - 6) Total Thickness: 1 inch.
  - 7) Glazing Method: Exterior wet/dry method, preformed tape and sealant.
- B. Low E Coating:
  - 1) Low E coating shall be located on the glass surface indicated for each glass type and have the following minimum properties:
    - a. Coating type: Sputter Coating.
    - b. Visible light transmission: 54 percent.
    - c. Shading coefficient: 0.30.
    - d. U- Value: .29.

### **2.02 GLAZING UNITS**

- A. Type GL2 - Tempered Safety Glazing:
  - 1) Application: Interior vestibule door and frame for storefront system and typical interior glass used at human-impact locations and where indicated on Contract Drawings.
  - 2) Type: Fully tempered safety glass.
  - 3) Tint: Clear.
  - 4) Thickness: 1/4 inch.
  - 5) Glazing Method: Interior dry method, tape and tape.

- 6) Safety Glazing Certification: 16 CFR 1201, Category I for doors w/ 9 SF of glass or less and Category II for sidelights greater than 9 SF of glass.

### **2.03 EXTERIOR GLAZING ASSEMBLIES**

- A. Performance Criteria: Select type and thickness of glass to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of glass.
  - 1) Design Pressure: Calculated in accordance with applicable codes.
  - 2) Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
  - 3) Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
  - 4) Glass thicknesses listed are minimum.

### **2.04 GLASS MATERIALS**

- A. Float Glass Manufacturers:
  - 1) Guardian Industries Corp.
  - 2) Pilkington North America Inc.
  - 3) PPG Industries, Inc.
  - 4) Old Castle Glass..
  - 5) Technical Glass Products (TGP)
  - 6) Substitutions: Refer to Section 01 60 00 - 01 60 00.
- B. Float Glass: Provide float glass based glazing unless noted otherwise.
  - 1) Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality-Q3.
  - 2) Heat-Strengthened and Fully Tempered Types: ASTM C1048, Kind HS and Kind FT.
  - 3) Tinted Types: ASTM C1036, Class 2 - Tinted, color and performance characteristics as indicated.
  - 4) Thicknesses: As indicated; for exterior glazing comply with requirements indicated for wind load design regardless of thickness indicated.
  - 5) Labels: Every individual piece of glass shall bear a label designating type, thickness and quality. Do not remove labels until observed by Architect.

### **2.05 SEALED INSULATING GLASS UNITS**

- A. Manufacturers:
  - 1) Any of the manufacturers specified for float glass.
  - 2) Substitutions: Refer to Section 01 60 00 - 01 60 00.
- B. Insulating Glass Units: Types as indicated.
  - 1) Application: Exterior glazing for storefront system at human impact areas and where required by code or indicated on Contract Drawings.
  - 2) Durability: Certified by an independent testing agency to comply with ASTM E2190.
  - 3) Metal Edge Spacers: Aluminum, bent and soldered corners.
  - 4) Spacer Color: Black.
  - 5) Edge Seal: Glass to elastomer with supplementary silicone sealant.
  - 6) Edge Seal Color: Black.
  - 7) Purge interpane space with dry air, hermetically sealed.
  - 8) Capillary Tubes: Provide tubes from air space for insulating glass units without inert type gas that have a change of altitude greater than 2500 feet between point of fabrication and point of installation to permit pressure equalization of air space.
    - a. Capillary Tubes: Tubes to remain open and be of length and material type in accordance with insulating glass fabricator's requirements.
  - 9) Glazing Method: Exterior dry method, tape and gasket spline.

## **2.06 GLAZING COMPOUNDS**

- A. Butyl Sealant: Single component; ASTM C920, Grade NS, Class 12-1/2, Uses M and A, Shore A hardness of 10 to 20; black color. Where required.

## **2.07 GLAZING ACCESSORIES**

- A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch x width of glazing rabbet space minus 1/16 inch x height to suit glazing method and pane weight and area.
- B. Glazing Tape: Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2 percent, designed for compression of 25 percent to effect an air barrier and vapor retarder seal; tape inch size as required for each opening.
- C. Glazing Gaskets: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; black color.
- D. Glazing Clips: Manufacturer's standard type.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that openings for glazing are correctly sized and within tolerance.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

### **3.02 PREPARATION**

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant.
- D. Install sealants in accordance with ASTM C1193 and GANA Sealant Manual.
- E. Install sealants in accordance with manufacturer's instructions.

### **3.03 INSTALLATION - EXTERIOR GLAZING IN ALUMINUM FRAMED DOORS AND WINDOWS**

- A. Comply with recommendations for installation contained in the FGMA "Glazing Manual" and "Sealant Manual" except when specifically not recommended or prohibited by the glazing or glazing accessory manufacturer; comply with manufacturer's recommendations.
- B. Install elastomeric setting blocks in sill rabbets, sized and located to company with referenced glazing standard, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- C. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- D. Provide spacers for glass sizes larger than 50 united inches (length plus height) as follows:
  - 1) Locate spacers inside, outside, and directly opposite each other. Install correct size and spacing to preserve required face clearances, except where gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and comply with system performance requirements.
  - 2) Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

- E. Provide edge blocking to comply with requirements of referenced glazing publications, unless otherwise required by glass manufacturer.
- F. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics. Glass bow is to be convex, bow out, to the exterior of the building.
- G. Square cut wedge-shaped gaskets at corners and install gaskets in manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

#### **3.04 INSTALLATION - INTERIOR DRY METHOD (TAPE AND TAPE)**

- A. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch above sight line.
- B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- C. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
- D. Place glazing tape on free perimeter of glazing in same manner described above.
- E. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
- F. Knife trim protruding tape.

#### **3.05 CLEANING**

- A. Remove glazing materials from finish surfaces.
- B. Remove labels after Work is complete.
- C. Clean glass and adjacent surfaces.

#### **3.06 PROTECTION**

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste.
- B. Breakage: Unless responsibility can be assessed to another sub-contractor, be responsible for glass broken during shipment, storage and installation.

**END OF SECTION**





**SECTION 09 05 61**  
**COMMON WORK RESULTS FOR FLOORING PREPARATION**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. This section applies to all floors identified in the contract documents as to receive the following types of floor coverings:
  - 1) Resilient tile and sheet.
  - 2) Thin-set ceramic tile.
- B. Preparation of existing concrete floor slabs for installation of floor coverings.
- C. Testing of concrete floor slabs for moisture and alkalinity (pH).
- D. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 22 00 - 01 22 00: Bid pricing for remediation treatments if required.
- B. Section 09 05 62 - Remedial Floor Coating: Floor coatings for slabs requiring remedial work.

**1.03 PRICE AND PAYMENT PROCEDURES**

- A. Unit Prices: See Section 01 22 00 - 01 22 00.
- B. Unit Price for Remedial Floor Coating: Do not include the cost of the floor coating in the base bid; state on the bid form the unit price per square foot for the floor coating, installed, in the event such remediation is required.
  - 1) Base the unit price on the assumption that the floor area to be treated is primarily open, not divided into rooms and corridors.

**1.04 REFERENCES**

- A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens); 2013.
- B. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2011.
- C. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2011.

**1.05 SUBMITTALS**

- A. Testing Agency's Report:
  - 1) Description of areas tested; include floor plans and photographs if helpful.
  - 2) Summary of conditions encountered.
  - 3) Moisture and alkalinity (pH) test reports.
  - 4) Copies of specified test methods.
  - 5) Recommendations for remediation of unsatisfactory surfaces.
  - 6) Submit report to Architect.
  - 7) Submit report not more than two business days after conclusion of testing.
- B. Adhesive Bond and Compatibility Test Report.
- C. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.
  - 1) Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.
  - 2) Manufacturer's installation instructions.

- 3) Specimen Warranty: Copy of warranty to be issued by coating manufacturer and certificate of underwriter's coverage of warranty.

## **1.06 QUALITY ASSURANCE**

- A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.
- B. Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.
  - 1) Submit evidence of experience consisting of at least 3 test reports of the type required, with project Owner's project contact information.
- C. Contractor's Responsibility Relating to Independent Agency Testing:
  - 1) Provide access for and cooperate with testing agency.
  - 2) Confirm date of start of testing at least 10 days prior to actual start.
  - 3) Allow at least 4 business days on site for testing agency activities.
  - 4) Achieve and maintain specified ambient conditions.
  - 5) Notify Architect when specified ambient conditions have been achieved and when testing will start.
- D. Remedial Coating Installer Qualifications: Company specializing in performing work of the type specified in this section, trained by or employed by coating manufacturer, and able to provide at least 3 project references showing at least 3 years' experience installing moisture emission coatings.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, handle, and protect products in accordance with manufacturer's instructions and recommendations.
- B. Deliver materials in manufacturer's packaging; include installation instructions.
- C. Keep materials from freezing.

## **1.08 FIELD CONDITIONS**

- A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.
- B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
  - 1) Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
  - 2) Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.
- B. Alternate Flooring Adhesive: Floor covering manufacturer's recommended product, suitable for the moisture and pH conditions present; low-VOC. In the absence of any recommendation from flooring manufacturer, provide a product recommended by

adhesive manufacturer as suitable for substrate and floor covering and for conditions present.

C. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.

1) Refer to Section 09 05 62 for remedial floor coating products.

### **PART 3 EXECUTION**

#### **3.01 CONCRETE SLAB PREPARATION**

A. Perform following operations in the order indicated:

- 1) Preliminary cleaning.
- 2) Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.
- 3) Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
- 4) Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
- 5) Specified remediation, if required.
- 6) Patching, smoothing, and leveling, as required.
- 7) Other preparation specified.
- 8) Adhesive bond and compatibility test.
- 9) Protection.

B. Remediations:

- 1) Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.
- 2) Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating over entire suspect floor area.
- 3) Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area or apply remedial floor coating over the entire suspect floor area.

#### **3.02 PRELIMINARY CLEANING**

A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.

B. Do not use solvents or other chemicals for cleaning.

#### **3.03 MOISTURE VAPOR EMISSION TESTING**

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

- C. Test in accordance with ASTM F1869 and as follows.
- D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.
- E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.
- F. Report: Report the information required by the test method.

#### **3.04 ALKALINITY TESTING**

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. The following procedure is the equivalent of that described in ASTM F710, repeated here for the Contractor's convenience.
- C. Use a wide range alkalinity (pH) test paper, its associated chart, and distilled or deionized water.
- D. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 inch in diameter. Allow the puddle to set for approximately 60 seconds, then dip the alkalinity (pH) test paper into the water, remove it, and compare immediately to chart to determine alkalinity (pH) reading.
- E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

#### **3.05 PREPARATION**

- A. See individual floor covering section(s) for additional requirements.
- B. Comply with requirements and recommendations of floor covering manufacturer.
- C. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.
- D. Do not fill expansion joints, isolation joints, or other moving joints.

#### **3.06 ADHESIVE BOND AND COMPATIBILITY TESTING**

- A. Comply with requirements and recommendations of floor covering manufacturer.

#### **3.07 APPLICATION OF REMEDIAL FLOOR COATING**

- A. Comply with requirements and recommendations of coating manufacturer.

#### **3.08 PROTECTION**

- A. Cover prepared floors with building paper or other durable covering.

**END OF SECTION**

## **SECTION 09 05 62 REMEDIAL FLOOR COATING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Floor coating for remediation of concrete floor slabs due to unsatisfactory moisture or pH conditions, prior to installation of adhesively applied floor coverings.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 09 05 61 - Common Work Results for Flooring Preparation: Testing of concrete floor slabs for moisture emission and alkalinity; additional remediation requirements.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2011.

#### **1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination: Coordinate the installation of coating with testing specified elsewhere.

#### **1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's published data on each product to be used for remediation.
- C. Manufacturer's qualification statement.
- D. Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.
- E. Manufacturer's installation instructions.
- F. Specimen Warranty: Copy of warranty to be issued by coating manufacturer and certificate of underwriter's coverage of warranty.
- G. Installer's qualification statement, certified by coating manufacturer.
- H. Warranty: Submit coating manufacturer's warranty and ensure that forms have been completed in UCCS's name and registered with manufacturer.

#### **1.06 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: At least 10 years' experience in production of moisture emission control coatings, documented by at least 5 project references.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, trained by or employed by coating manufacturer, and able to provide at least 3 project references showing at least 3 years' experience installing moisture emission coatings.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, handle, and protect in accordance with manufacturer's instructions and recommendations.
- B. Deliver materials in manufacturer's packaging; include installation instructions.
- C. Keep materials from freezing.

### **PART 2 PRODUCTS**

#### **2.01 MATERIALS**

- A. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to

meet flooring manufacturer's emission limits, resistant to the level of pH found, and suitable for adhesion of flooring without further treatment.

- 1) Thickness: As required for application and in accordance with manufacturer's installation instruction.
  - 2) Products: As recommended by flooring adhesive manufacturer for compatibility.
    - a. ARDEX Engineered Cements.
    - b. Floor Seal Technology, Inc.
    - c. Substitutions: See Section 01 60 00 - 01 60 00.
- B. Cementitious Patching Compound: 100-percent Portland cement-based self-leveling compound capable of providing adequate bond for subsequently applied floor adhesives; approved by remedial coating manufacturer.
- 1) Products:
    - a. ARDEX Engineered Cements, Inc; ARDEX K-15.
    - b. Mapei International; Mapei Ultraplan 1 Plus.
    - c. Substitutions: See Section 01 60 00 - 01 60 00.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine floor slabs where work is to be performed.
- B. Notify Architect in writing of conditions detrimental to proper or timely installation.
- C. Do not proceed until detrimental conditions have been corrected.
- D. See Section 09 05 61 for moisture emission and alkalinity testing.

#### **3.02 INSTALLATION**

- A. Install remedial coating over all concrete floor areas where moisture emission and/or alkalinity exceeds the floor covering manufacturer's published limits.
- B. Prepare floor areas to be coated in accordance with coating manufacturer's requirements.
  - 1) Mask and protect adjacent wall and floor surfaces from damage due to this work.
- C. Apply coating using manufacturer's recommended procedures.
- D. Verify that prepared floor slab has moisture emission rate and alkalinity meeting requirements.

**END OF SECTION**

## **SECTION 09 21 16**

### **GYPSUM BOARD ASSEMBLIES**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Metal stud wall framing.
- B. Metal channel ceiling framing.
- C. Gypsum wallboard.
- D. Joint treatment and accessories.
- E. Textured finish system.
- F. Exterior soffit board.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 05 50 00 - Metal Fabrications: Sheet metal blocking.
- B. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 07 21 00 - Thermal Insulation: Acoustic insulation.
- D. Section 07 84 00 - Firestopping: Top-of-wall assemblies at fire rated walls.
- E. Section 07 92 00 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

##### **1.03 REFERENCE STANDARDS**

- A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2012.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- C. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2015.
- D. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2014.
- E. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2015.
- F. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2013.
- G. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2015.
- H. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2014.
- I. ASTM C1047 - Standard Specification for Accessories For Gypsum Wallboard and Gypsum Veneer Base; 2014a.
- J. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2013.
- K. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2013.
- L. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2014.

- M. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2015.
- N. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels; 2013.
- O. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2012.
- P. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- Q. GA-216 - Application and Finishing of Gypsum Board; 2013.
- R. GA-600 - Fire Resistance Design Manual; 2015.
- S. ICC (IBC) - International Building Code; 2015.
- T. UL (FRD) - Fire Resistance Directory; current edition.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate locations and special details associated with control and expansion joint locations.
- C. Product Data: Provide data on metal framing, gypsum board, glass mat faced gypsum board, accessories, and joint finishing system.
- D. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

#### **1.05 QUALITY ASSURANCE**

- A. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.
- B. Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.

#### **1.07 PROJECT CONDITIONS**

- A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.
- B. Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40 deg F. For adhesive attachment and finishing of gypsum board, maintain not less than 50 deg F for 48 hours before application and continuously after until dry. Do not exceed 95 deg F when using temporary heat sources.
- C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.



## **PART 2 PRODUCTS**

### **2.01 METAL FRAMING MATERIALS**

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
  - 1) Clarkwestern Dietrich Building Systems LLC.
  - 2) Marino.
  - 3) Phillips Manufacturing Company.
  - 4) CEMCO.
- B. Non-Loadbearing Framing System Components: ASTM C645; of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
  - 1) Thickness: 25 ga. unless otherwise noted.
  - 2) Thickness: 20 ga at ceramic tile wall installations.
  - 3) Depth: As indicated on Contract Drawings.
  - 4) Studs: "C" shaped with flat or formed webs with knurled faces.
  - 5) Runners: U shaped, sized to match studs.
  - 6) Ceiling Channels: C-shaped.
  - 7) Furring: Hat-shaped sections, minimum depth of 7/8 inch. 21 ga unless otherwise indicated.
  - 8) Protective Coating: ASTM A 653, G 40 (ASTM A 653M, Z 90) hot-dip galvanized coating for framing members.
- C. Steel Framing Components for Suspended Ceilings:
  - 1) General: Provide components complying with ASTM C 754 for conditions indicated.
  - 2) Wire Ties: ASTM A 641 (ASTM A 641M), Class 1 zinc coating, soft temper, 0.062 inch thick.
  - 3) Wire Hangers: ASTM A 641 (ASTM A 641M), Class 1 zinc coating, soft temper, 0.162-inch diameter.
  - 4) Hanger Rods: Mild steel and zinc coated or protected with rust-inhibitive paint.
  - 5) Flat Hangers: Mild steel and zinc coated or protected with rust-inhibitive paint.
  - 6) Channels: Cold-rolled steel, 0.0598-inch minimum thickness of base (uncoated) metal and 7/16-inch- wide flanges, and as follows:
    - a. Carrying Channels: 1-1/2 inches deep, 475 lb/1000 feet, unless otherwise indicated.
    - b. Furring Channels: 3/4 inch deep, 300 lb/1000 feet, unless otherwise indicated.
    - c. Finish: Rust-inhibitive paint, unless otherwise indicated.
  - 7) Grid Suspension System for Interior Ceilings: ASTM C 645, manufacturer's standard direct-hung grid suspension system composed of main beams and cross-furring members that interlock to form a modular supporting network.
- D. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
  - 1) Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
  - 2) Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G40/Z180 hot dipped galvanized coating.
  - 3) Provide components UL-listed for use in UL-listed fire-rated head of partition joint systems of fire rating and movement required.
  - 4) Deflection and Firestop Track:

- a. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-rating of the wall assembly.
- b. Products:
  - 1) FireTrak Corporation; Posi Klip.
  - 2) Metal-Lite, Inc.; The System.
  - 3) Substitutions: See Section 01 60 00 - 01 60 00.

## 2.02 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
  - 1) American Gypsum Company.
  - 2) Georgia-Pacific Gypsum.
  - 3) National Gypsum Company.
  - 4) USG Corporation.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut; edges tapered.
  - 1) Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
  - 2) Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
  - 3) Thickness:
    - a. Vertical Surfaces: 5/8 inch.
    - b. Ceilings: 5/8 inch.
  - 4) Rating:
    - a. Type "X" board where indicated.
    - b. Type "S" board where indicated.
- C. Abuse Resistant Wallboard:
  - 1) Application: Mechanical room.
  - 2) Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
  - 3) Type: Fire resistance rated Type X, UL or WH listed.
  - 4) Thickness: 5/8 inch.
  - 5) Edges: Tapered.
- D. Backing Board For Wet Areas:
  - 1) Application: Surfaces behind tile in wet areas including toilet rooms.
  - 2) Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
  - 3) Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
    - a. Standard Type: Thickness 5/8" inch.
    - b. Standard Type: Thickness 1/4" inch.
    - c. Fire Resistant Type: Type X core, thickness 5/8 inch.
- E. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
  - 1) Application: Ceilings, unless otherwise indicated.
  - 2) Thickness: 1/2 inch.
  - 3) Edges: Tapered.
- F. Exterior Soffit Board: Exterior gypsum soffit board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
  - 1) Application: Ceilings and soffits in protected exterior areas, unless otherwise indicated.
  - 2) Regular Type Thickness: 1/2 inch.
  - 3) Edges: Tapered.

## **2.03 ACCESSORIES**

- A. Acoustic Insulation: As specified in Section 07 21 00.
- B. Acoustical Sealant: As specified in Section 07 92 00.
- C. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
  - 1) Types: As detailed or required for finished appearance.
  - 2) Special Shapes: In addition to conventional corner bead and control joints, provide U-bead at exposed panel edges.
  - 3) Control Joint: USG No. 093 or equivalent.
- D. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
  - 1) Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
  - 2) Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
  - 3) Ready-mixed vinyl-based joint compound.
  - 4) Chemical hardening type compound.
- E. Textured Finish Materials: Latex-based compound; plain.
- F. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inch in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion resistant.
- G. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion resistant.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that project conditions are appropriate for work of this section to commence.

### **3.02 PREPARATION**

- A. Ceiling Anchorages: Coordinate installation of ceiling suspension systems with installation of overhead structural assemblies to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers that will develop their full strength and at spacing required to support ceilings.
  - 1) Furnish devices indicated to other trades for installation well in advance of time needed for coordination with other construction.

### **3.03 FRAMING INSTALLATION**

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
  - 1) Suspend ceiling hangers from building structural members and as follows:
    - a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
    - b. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size

supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

- c. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
  - d. Secure flat, angle, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or otherwise fail.
  - e. Do not support ceilings directly from permanent metal forms.
  - f. Do not attach hangers to steel deck tabs.
  - g. Do not attach hangers to steel deck. Attach hangers to structural members.
  - h. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- 2) Install suspended steel framing components in sizes and at spacings indicated, but not less than that required by the referenced steel framing installation standard.
    - a. Wire Hangers: 48 inches o.c.
    - b. Carrying Channels (Main Runners): 48 inches o.c.
    - c. Furring Channels (Furring Members): 24 inches o.c.
  - 3) Install bracing as required at exterior locations to resist wind uplift.
- C. Studs: Space studs at 16" o.c. unless otherwise indicated.
- 1) Extend partition framing as indicated on Contract Drawings.
  - 2) Install steel studs so flanges point in the same direction and leading edge or end of each gypsum board panel can be attached to open (unsupported) edges of stud flanges first.
  - 3) Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
  - 4) Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- 1) Frame door openings to comply with GA-219, and with applicable published recommendations of gypsum board manufacturer, unless otherwise indicated. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
    - a. Install two (2) 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.
    - c. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- E. Blocking: Install wood or sheet metal blocking for support of:
- 1) Framed openings.
  - 2) Wall mounted cabinets.
  - 3) Plumbing fixtures.
  - 4) Toilet partitions.

- 5) Toilet accessories.
- 6) Wall mounted door hardware.
- 7) Other wall mounted items.

### **3.04 ACOUSTIC ACCESSORIES INSTALLATION**

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install as follows:
  - 1) Place one bead continuously on substrate before installation of perimeter framing members.
  - 2) Place continuous bead at perimeter of each layer of gypsum board.
  - 3) Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.

### **3.05 BOARD INSTALLATION**

- A. Comply with ASTM C 840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
  - 1) Install gypsum board sheets a minimum of 1/4" off the floor.
- B. Single-Layer Non-Rated: Install gypsum board perpendicular to framing, with ends and edges occurring over firm bearing.
  - 1) Exception: Tapered edges to receive joint treatment at right angles to framing.
- C. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- D. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.
- E. Exterior Soffits: Install exterior soffit board perpendicular to framing, with staggered end joints over framing members or other solid backing.
  - 1) Seal joints, cut edges, and holes with water resistant sealant.
- F. Installation on Metal Framing: Use screws for attachment of gypsum board.

### **3.06 INSTALLATION OF TRIM AND ACCESSORIES**

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
  - 1) Not more than 30 feet apart on walls and ceilings over 50 feet long.
  - 2) At exterior soffits, not more than 30 feet apart in both directions.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

### **3.07 JOINT TREATMENT**

- A. Glass Mat Faced Gypsum Board: Use fiberglass joint tape, bedded and finished with chemical hardening type joint compound.
- B. Paper Faced Gypsum Board: Use paper joint tape, bedded with ready-mixed vinyl-based joint compound and finished with ready-mixed vinyl-based joint compound.
- C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
  - 1) Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
  - 2) Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.

- 3) Level 1: Fire-resistive-rated assemblies, sound-rated assemblies, or as indicated on Contract Drawings areas above finished ceilings, whether or not accessible in the completed construction.
- D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
  - 1) Feather coats of joint compound so that camber is maximum 1/32 inch.

**3.08 TEXTURE FINISH**

- A. Texture Required: Smooth unless otherwise indicated.

**3.09 TOLERANCES**

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

**3.10 CLEANING AND PROTECTION**

- A. Promptly remove any residual joint compound from adjacent surfaces.
- B. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure gypsum board assemblies are without damage or deterioration at the time of Substantial Completion.

**END OF SECTION**

## **SECTION 09 30 00**

### **TILING**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Coated glass mat backer board as tile substrate.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 01 22 00 - Unit Prices: Unit price to add concrete subfloor sealer.
- B. Section 07 92 00 - Joint Sealants: Sealing joints between tile work and adjacent construction and fixtures.
- C. Section 09 05 61 - Common Work Results for Flooring Preparation.
- D. Section 09 05 62 - Remedial Floor Coating.
- E. Section 09 21 16 - Gypsum Board Assemblies: Tile backer board.
- F. Section 22 40 00 - Plumbing Fixtures.

##### **1.03 REFERENCE STANDARDS**

- A. ANSI A108/A118/A136.1 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2013.1.
- B. ANSI A118.1 - American National Standard Specifications for Dry-Set Cement Mortar; 2012 (Revised).
- C. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar; 2012 (Revised).
- D. ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation; 2010 (Revised).
- E. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-set Ceramic Tile and Dimension Stone Installation; 2014.
- F. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2013.1.
- G. ASTM C373 - Standard Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products, Ceramic Tiles, and Glass Tiles; 2014a.
- H. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2013.
- I. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2011.
- J. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2011.
- K. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2015.

##### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Shop Drawings: Indicate tile layout, patterns, perimeter conditions, junctions with dissimilar materials, control and expansion joints, and setting details.

- D. Samples: Submit full range of manufacturer's standard colors and profiles of ceramic tile and grout indicated to Architect for color selection.
- E. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.
- F. Maintenance Materials: Furnish the following for UCCS's use in maintenance of project.
  - 1) See Section 01 60 00 - 01 60 00, for additional provisions.
  - 2) Extra Tile: 2 percent of each size, color, and surface finish combination.

#### **1.05 QUALITY ASSURANCE**

- A. Maintain one copy of and ANSI A108/A118/A136.1 and TCNA (HB) on site.
- B. Installer Qualifications: Company specializing in performing tile installation, with minimum of five years of documented experience.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

#### **1.07 FIELD CONDITIONS**

- A. Maintain ambient and substrate temperature of 50 degrees F during installation of mortar materials.

### **PART 2 PRODUCTS**

#### **2.01 TILE**

- A. Manufacturers: All products of each type by the same manufacturer.
  - 1) Dal-Tile Corporation.
  - 2) Substitutions: Not permitted.
- B. Porcelain Tile, Type T1 - Field Tile: ANSI A137.1, standard grade.
  - 1) Manufacturer: Dalfile.
  - 2) Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
  - 3) Size: 12" by 24" inch, nominal.
  - 4) Thickness: 3/8 inch.
  - 5) Edges: Square.
  - 6) Surface Finish: Matte glazed.
  - 7) Color(s): Origami White Flat MU16.
  - 8) Pattern: Multitude.
- C. Porcelain Tile, Type T2 - Accent Tile: ANSI A137.1, standard grade.
  - 1) Manufacturer: Dalfile.
  - 2) Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
  - 3) Size: 12" by 24" inch, nominal.
  - 4) Thickness: 3/8 inch.
  - 5) Edges: Square.
  - 6) Surface Finish: Matte glazed.
  - 7) Color(s): Origami White Wave MU16.
  - 8) Pattern: Multitude.
- D. Porcelain Tile, Type T3 - Tile Base: ANSI A137.1, standard grade.
  - 1) Manufacturer: Dalfile.
  - 2) Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
  - 3) Size: 3"by24" inch, nominal.
  - 4) Thickness: 3/8 inch.
  - 5) Edges: Bullnose.



- 6) Surface Finish: Matte glazed.
  - 7) Color(s): Black Drama P266.
  - 8) Pattern: P'zazz.
- E. Porcelain Tile, Type T4 - Floor Tile: ANSI A137.1, standard grade.
    - 1) Manufacturer: Dalfile.
    - 2) Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
    - 3) Size: 12"by24" inch, nominal.
    - 4) Thickness: 3/8 inch.
    - 5) Edges: Square.
    - 6) Surface Finish: Non-slip.
    - 7) Color(s): Creme Linen P686.
    - 8) Pattern: Fabrique.
  - F. Porcelain Tile, Type T5 - Accent Tile: ANSI A137.1, standard grade.
    - 1) Manufacturer: Dalfile.
    - 2) Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
    - 3) Size: 2" by 2" inch, nominal.
    - 4) Thickness: 3/8 inch.
    - 5) Edges: Square.
    - 6) Surface Finish: Matte glazed.
    - 7) Color(s): Black Drama P266.
    - 8) Pattern: P'zazz.

## 2.02 TRIM AND ACCESSORIES

- A. Schluter Systems: Trim as selected.
- B. Edge Trim Tile:
  - 1) Manufacturer: Dalfile.
  - 2) Series: Urban Metals.
  - 3) Style: Gunmetal.
  - 4) Size: Jolly 1/2x12 UM03.

## 2.03 SETTING MATERIALS

- A. Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.
  - 1) Applications: Use this type of bond coat where indicated and where no other type of bond coat is indicated.
  - 2) Products:
    - a. ARDEX Engineered Cements; ARDEX X 77 MICROTEC.
    - b. Custom Building Products; Complete Contact-LFT Premium Rapid Setting Large Format Tile Mortar, with Multi-Surface Bonding Primer.
    - c. LATICRETE International, Inc; LATICRETE 254 Platinum.
    - d. Merkrete, by Parex USA, Inc; Merkrete 720 Marble Pro.
    - e. ProSpec, an Oldcastle brand; Permalastic System.
    - f. Substitutions: See Section 01 60 00 - 01 60 00.

## 2.04 GROUTS

- A. Standard Grout: ANSI A118.6 standard cement grout.
  - 1) Applications: Use this type of grout where indicated and where no other type of grout is indicated.
  - 2) Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.
  - 3) Color(s): As selected by Architect from manufacturer's full line.
  - 4) Products:

- a. Custom Building Products; Polyblend Non-Sanded Grout.
- b. LATICRETE International, Inc; LATICRETE 1500 Sanded Grout.
- c. Merkrete, by Parex USA, Inc; Merkrete Integra Color Grout.
- d. ProSpec, an Oldcastle brand; ProColor Sanded Tile Grout.
- e. Substitutions: See Section 01 60 00 - 01 60 00.

## **2.05 MAINTENANCE MATERIALS**

- A. Tile Sealant: Gunnable, silicone, siliconized acrylic, or urethane sealant; moisture and mildew resistant type.
  - 1) Applications: Between tile and plumbing fixtures.
  - 2) Color(s): As selected by Architect from manufacturer's full line.
- B. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
  - 1) Composition: Water-based pigmented urethane acrylic.
  - 2) Color(s): As selected by Architect from manufacturer's full line.

## **2.06 ACCESSORY MATERIALS**

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
  - 1) Type: Fluid-applied.
  - 2) Thickness: 20 mils, maximum.
  - 3) Crack Resistance: No failure at 1/16 inch gap, minimum.
  - 4) Products:
    - a. LATICRETE International, Inc.
    - b. Merkrete, by Parex USA, Inc..
    - c. Substitutions: See Section 01 60 00 - 01 60 00.
- B. Backer Board: Coated glass mat type complying with ASTM C1178/C1178M; inorganic fiberglass mat on both surfaces and integral acrylic coating vapor retarder. See Section 09 21 16, Gypsum Board Assemblies.
- C. Mesh Tape: 2 inch wide self-adhesive fiberglass mesh tape.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of setting materials to sub-floor surfaces.
- D. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:
  - 1) Moisture Emission Rate: Not greater than 3 lb per 1000 sq ft per 24 hours, test in accordance with ASTM F1869.
  - 2) Alkalinity (pH): Verify pH range of 5 to 9, test in accordance with ASTM F710.
- E. Verify that required floor-mounted utilities are in correct location.

### **3.02 PREPARATION**

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.

- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Crack Isolation Membrane:
  - 1) Provide crack isolation membrane at floor cracks per Tile Council of America for interior floor crack isolation membrane, partial coverage and A3.4 of ANSI A1008 series.
- E. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.
- F. If required provide remedial floor coating per Section 09 05 62, "Remedial Floor Coating".
- G. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.

### **3.03 INSTALLATION - GENERAL**

- A. Install tile and grout in accordance with applicable requirements of ANSI A108.1a thru A108.13, manufacturer's instructions, and TCNA (HB) recommendations.
- B. Unless otherwise noted on Contract Drawings or on approved shop drawings, lay tile in grid pattern as indicated on contract drawings. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout. Provide joint width of 1/16" inch for ceramic tile.
- E. Form internal angles square and external angles bullnosed.
- F. Sound tile after setting. Replace hollow sounding units.
- G. Keep control and expansion joints free of mortar, grout, and adhesive.
- H. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- I. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
- J. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

### **3.04 INSTALLATION - FLOORS - THIN-SET METHODS**

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.

### **3.05 INSTALLATION - WALL TILE**

- A. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.
- B. Over gypsum wallboard on wood or metal studs install in accordance with TCNA (HB) Method W243, thin-set with dry-set or latex-Portland cement bond coat, unless otherwise indicated.

### **3.06 CLEANING**

- A. Clean tile and grout surfaces.

### **3.07 PROTECTION**

- A. Do not permit traffic over finished floor surface for 4 days after installation.

**END OF SECTION**

## **SECTION 09 65 00 RESILIENT FLOORING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Resilient tile flooring.
- B. Resilient base.
- C. Installation accessories.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 22 00 - Unit Prices: Unit price to add concrete subfloor sealer.
- B. Section 09 05 61 - Common Work Results for Flooring Preparation: Independent agency testing of concrete slabs, removal of existing floor coverings, cleaning, and preparation.
- C. Section 09 05 62 - Remedial Floor Coating: Floor coatings for slabs requiring remedial work.
- D. Section 09 21 16 - Gypsum Board Assemblies: Rubber base with gypsum board walls.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2011.
- B. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile; 2004 (Reapproved 2014).
- C. ASTM F1861 - Standard Specification for Resilient Wall Base; 2008 (Reapproved 2012).
- D. ASTM F2169 - Standard Specification for Resilient Stair Treads; 2015.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Selection Samples: Submit manufacturer's complete set of standard color samples for Architect's selection.
- D. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.
- E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
- F. Maintenance Materials: Furnish the following for UCCS's use in maintenance of project.
  - 1) See Section 01 60 00 - 01 60 00, for additional provisions.
  - 2) Extra Flooring Material: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.
  - 3) Extra Wall Base: 10 linear feet for every 500 linear of each type and color.
  - 4) One (1) gallon of each type of adhesive used.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B. Store all materials off of the floor in an acclimatized, weather-tight space.

- C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.

## **1.06 FIELD CONDITIONS**

- A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.
- B. Close spaces to traffic during floor covering installation.
- C. Close spaces to traffic for 48 hours after floor covering installation.
- D. Install resilient products after other finishing operations, including painting, have been completed.

## **PART 2 PRODUCTS**

### **2.01 TILE FLOORING**

- A. Vinyl Composition Tile: Homogeneous, with color extending throughout thickness.
  - 1) Minimum Requirements: Comply with ASTM F1066, of Class corresponding to type specified.
  - 2) Size: 12 by 12 inch.
  - 3) Thickness: 0.125 inch.
  - 4) Pattern: As selected by Architect.
  - 5) Manufacturers:
    - a. Armstrong World Industries, Inc.
    - b. Johnsonite, a Tarkett Company. Azrock VCT
  - 6) The products listed below are for basis-of-design:
    - a. Vinyl Composition Tile Flooring:
    - b. Armstrong Standard Excelon Imperial Texture: 12" x 12" x 1/8".
      - 1) Up to (4) colors may be selected by Architect
      - 2) Provide slip resistant tile in areas noted on the Contract Drawings.

### **2.02 RESILIENT BASE**

- A. Resilient Base: ASTM F1861, Type TP, rubber, thermoplastic; top set Style A, Straight at carpet and Style B, Cove for other locations.
  - 1) Height: 4 inch.
  - 2) Thickness: 0.125 inch thick.
  - 3) Finish: Matte.
  - 4) Length: Roll.
  - 5) Color: Color as selected from manufacturer's standards.
  - 6) Preformed corners not permitted.
  - 7) Manufacturers:
    - a. Johnsonite, a Tarkett Company; BaseWorks Thermoset Rubber Wall Base.
    - b. Roppe Corp.
    - c. Flexco.

### **2.03 ACCESSORIES**

- A. Subfloor Filler: Self leveling; type recommended by adhesive material manufacturer.
- B. Flooring Adhesive:
  - 1) Manufacturers:
    - a. As recommended by manufacturer in writing.
- C. Moldings, Transition and Edge Strips: See below.

- 1) Furnish at exposed edges of resilient floor tile, rubber edging one (1)" wide, 1/8" thick, with bevel slope not exceeding 1:2. Colors and profile as selected by Architect from manufacturer's range of colors and profiles.
- D. Sealer and Wax: Types recommended by flooring manufacturer and are acceptable to Owner.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and pH.
  - 1) Test in accordance with Section 09 05 61.
  - 2) Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- D. Verify that required floor-mounted utilities are in correct location.

#### **3.02 PREPARATION**

- A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.
- B. If required provide remedial floor coating per Section 09 05 62, "Remedial Floor Coating".
- C. Clean substrate.

#### **3.03 INSTALLATION**

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Fit joints and butt seams tightly.
- E. Set flooring in place, press with heavy roller to attain full adhesion.
- F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
- H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

#### **3.04 TILE FLOORING**

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.
- B. Layout: Work out patterns for each floor area and cuts against walls so cuts on opposite sides of the area are of same width. In order to eliminate small cuts against walls, lay out each area to determine whether pattern should start with a joint or center of a tile on the center line of the area each direction. Terminate flooring at centerline of closed door at openings where adjacent floor finish is different. Where tile with a directional pattern is used, confer with Architect for direction of jaspers. Jaspers

(pattern) will be run in one direction within rooms or areas - no checkerboard of tile with directional pattern will be allowed unless specifically noted otherwise by the Architect.

- C. Lay flooring with joints and seams parallel to building lines to produce symmetrical tile pattern.

### **3.05 RESILIENT BASE**

- A. Install base after finish floor material has been installed.
- B. Install base in toe space of cabinets, including cabinets.
- C. Fit joints tightly and make vertical 1/6" or less. Maintain minimum dimension of 36" inches between joints.
- D. Do not install any resilient base shorter than 24".
- E. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units. Scribe and fit to door frames, interruptions and returns longer than 3/4".
- F. Install base on solid backing. Bond tightly to wall and floor surfaces.

### **3.06 CLEANING**

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.

**END OF SECTION**



## **SECTION 09 91 13 EXTERIOR PAINTING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Surface preparation.
- B. Field application of paints.
- C. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
- D. Do Not Paint or Finish the Following Items:
  - 1) Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
  - 2) Items indicated to receive other finishes.
  - 3) Items indicated to remain unfinished.
  - 4) Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
  - 5) Non-metallic roofing and flashing.
  - 6) Stainless steel, anodized aluminum, bronze, terne coated stainless steel, zinc, and lead.
  - 7) Floors, unless specifically indicated.
  - 8) Brick, glass unit masonry, architectural concrete, cast stone, integrally colored plaster and stucco.
  - 9) Exterior insulation and finish system (EIFS).
  - 10) Glass.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 05 05 13 - Shop-Applied Metal Finishes: Powder coating of exterior steel pipe bollards and railings.
- C. Section 05 50 00 - Metal Fabrications: Exterior shop-primed metal fabrications.

#### **1.03 DEFINITIONS**

- A. Conform to ASTM D16 for interpretation of terms used in this section.

#### **1.04 REFERENCE STANDARDS**

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2014.
- C. SSPC-SP 1 - Solvent Cleaning; 2015.
- D. SSPC-SP 2 - Hand Tool Cleaning; 1982 (Ed. 2004).
- E. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

#### **1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Color Schedule: The Architect will provide a color schedule to the Contractor after a paint manufacturer is selected and color chips have been submitted.
- C. Product Data: Provide complete list of products to be used, with the following information for each:

- 1) Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
  - 2) Cross-reference to specified paint system(s) product is to be used in; include description of each system.
  - 3) Manufacturer's installation instructions.
- D. Samples: Submit two painted samples, illustrating selected colors for each color and system selected. Submit on paint suppliers standard sample material, 8" by 10" inch in size.
- E. Certification: By manufacturer that paints and finishes comply with VOC limits specified.
- F. Manufacturer's Instructions: Indicate special surface preparation procedures.
- G. Maintenance Materials: Furnish the following for the Owner's use in maintenance of the project.
- 1) See Section 01 60 00 - 01 60 00, for additional provisions.
  - 2) Extra Paint and Finish Materials: 1 gallon of each color and type; from the same product run,.
  - 3) Label each container with color and color number or formula for each type in addition to the manufacturer's label.

#### **1.06 QUALITY ASSURANCE**

- A. Applicator Qualifications: Company specializing in performing painting on projects with the same type of material and extent of work as indicated for this project, and approved by manufacturer.
- B. Single-Source Responsibility: Provide primers and undercoat material produced by the same manufacturer as the finish coats for each type of coating. Use only thinners recommended by the manufacturer and only within recommended limits.
- C. Comply with EPA guidelines regarding paints formulated with any of the following ingredients, in any amount:
- 1) Red lead.
  - 2) Basic lead silico chromate.
  - 3) Zinc chromate.
  - 4) Lead driers.

#### **1.07 MATERIAL QUALITY**

- A. All products not specified by name shall be "best grade" or "first line" products of acceptable manufacturers. See Part 3 Execution for materials required for this project. Where possible, materials shall be of a single manufacturer. Paint material containers not displaying manufacturer's product identification will not be acceptable.
- B. Proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude equal products of other manufacturers.

#### **1.08 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

- D. Storage and Mixing: Painter will be assigned a room or space in which to mix or store material. Provide galvanized mixing pans for this paint room or space in which paints shall be mixed. No mixing of paint shall be done except in these pans. Empty containers bearing the name or brand of any manufacturer shall not be brought upon the premises for mixing of paint unless labels are canceled and containers are closely marked as to contents.

### **1.09 FIELD CONDITIONS**

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply exterior paint and finishes during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- D. Minimum Application Temperatures for Latex Paints: 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Provide paints and finishes from the same manufacturer.
  - 1) In the event that a single manufacturer cannot provide specified products, minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
- B. Paints:
  - 1) Benjamin Moore & Co.
  - 2) Diamond Vogel Paints.
  - 3) Glidden Professional, a product of PPG Architectural Coatings.
  - 4) PPG Paints.
  - 5) Kwal Paint.
  - 6) Sherwin-Williams Company.
  - 7) Coronado Paint Company.
  - 8) Tnemec Company, Inc..
- C. Substitutions: See Section 01 60 00 - 01 60 00.

### **2.02 PAINTS AND FINISHES - GENERAL**

- A. Paints and Finishes: Ready mixed, unless required to be a field-catalyzed paint.
  - 1) Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
  - 2) Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
  - 3) For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
  - 4) Supply each paint material in quantity required to complete entire project's work from a single production run.
  - 5) Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content:

- 1) Provide paints and finishes that comply with the most stringent requirements specified in the following:
    - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
    - b. Architectural coatings VOC limits of the State in which the Project is located.
  - 2) Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
- C. Flammability: Comply with applicable code for surface burning characteristics.
- D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- E. Colors: To be selected from manufacturer's full range of available colors.
  - 1) Selection to be made by Architect after award of contract.
  - 2) Extend colors to surface edges; colors may change at any edge as directed by Architect.

### **2.03 ACCESSORY MATERIALS**

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Coordinating Work: Review sections in which other coatings are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on the characteristics of specified finish materials to ensure compatible primers.
  - 1) Notify the Architect of problems anticipated using the coatings specified over substrates primed by others.

### **3.02 PREPARATION**

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Exterior Plaster: Fill hairline cracks, small holes, and imperfections with exterior patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.

- F. Stucco: Fill hairline cracks, small holes, and imperfections with stucco patching material. Match adjacent texture.
- G. Galvanized Surfaces:
  - 1) Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
  - 2) Prepare surface according to SSPC-SP 2.
- H. Ferrous Metal:
  - 1) Solvent clean according to SSPC-SP1.
  - 2) Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
  - 3) Remove rust, loose mill scale, and other foreign substances using using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning". Protect from corrosion until coated.
- I. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

### **3.03 APPLICATION**

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Protection: Furnish and lay drop cloths or mask off areas where finishing is being done to protect horizontal surfaces and other work from damage during the execution of work. Where it becomes necessary to remove temporary coverings place by others, replace same in proper manner.
- C. Apply products in accordance with manufacturer's written instructions.
- D. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- E. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- F. Apply each coat to uniform appearance.
- G. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply additional coats until complete hide is achieved.
- H. Sand wood and metal surfaces lightly between coats to achieve required finish.

### **3.04 CLEANING**

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Final Clean-Up: At the completion of work, remove all surplus materials, staging, rubbish; clean off all paint from horizontal surfaces, glass, prefinished products, adjacent walls, hardware; and leave the premises in clean condition.

### **3.05 PROTECTION**

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

### **3.06 SCHEDULE - PAINT SYSTEMS**

- A. Exposed Concrete - Painted:
  - 1) First Coat Loxon Acrylic masonry primer (Tint to match finish coat color)
  - 2) One to two coats UltraCrete fine textured coating.
- B. Precast Concrete Wall Panels - Painted:

- 1) First Coat Loxon Acrylic masonry primer (Tint to match finish coat color)
  - 2) One to two coats UltraCrete fine textured coating.
- C. Hollow Metal Frames and Doors, Ferrous Metals:
- 1) First Coat Suitable Primer if not already prime painted.
  - 2) Second Coat Industrial Alkyd Enamel, Semi-Gloss
  - 3) Third Coat Industrial Alkyd Enamel, Semi-Gloss
- D. Exterior Plaster Soffit: Finish surfaces exposed to view.
- 1) First Coat Suitable Primer
  - 2) Second Coat Exterior Acrylic Latex, Flat
  - 3) Third Coat Exterior Acrylic Latex, Flat
- E. Exterior Stucco: Finish surfaces exposed to view (Basis-of-Design to be Sherwin-Williams).
- 1) First Coat Loxon XP, A24-1400 Series (14.0 mills wet; 6.4 mills dry per coat)
- F. Steel Fabrications: Pipe Bollards and Railings.
- 1) Powder Coated Finish per Section 05 05 13: Shop-Applied Metal Finishes.
- G. Steel Fabrications Other Than Pipe Bollards and Railings: Finish surfaces exposed to view.
- 1) First Coat Suitable Primer if not already prime painted.
  - 2) Second Coat Industrial Alkyd Enamel, Semi-Gloss
  - 3) Third Coat Industrial Alkyd Enamel, Semi-Gloss
- H. Galvanized Steel: Finish surfaces exposed to view.
- 1) First Coat Suitable Primer if not already prime painted.
  - 2) Second Coat Industrial Alkyd Enamel, Semi-Gloss
  - 3) Third Coat Industrial Alkyd Enamel, Semi-Gloss
- I. Shop-Primed Metal Items: Finish surfaces exposed to view.
- 1) Finish the following items:
    - a. Exposed surfaces of lintels.
    - b. Mechanical equipment.
  - 2) First Coat Suitable Primer if not already prime painted.
  - 3) Second Coat Industrial Alkyd Enamel, Semi-Gloss
  - 4) Third Coat Industrial Alkyd Enamel, Semi-Gloss
- J. Exterior Pavement Markings:
- 1) See Section 32 17 23.13 - Painted Pavement Markings.

**END OF SECTION**

## **SECTION 09 91 23 INTERIOR PAINTING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Surface preparation.
- B. Field application of paints, stains, and varnishes.
- C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
  - 1) Prime surfaces to receive wall coverings.
- D. Do Not Paint or Finish the Following Items:
  - 1) Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
  - 2) Items indicated to receive other finishes.
  - 3) Items indicated to remain unfinished.
  - 4) Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
  - 5) Stainless steel, anodized aluminum, bronze, terne coated stainless steel, and lead items.
  - 6) Marble, granite, slate, and other natural stones.
  - 7) Floors, unless specifically indicated.
  - 8) Ceramic and other tiles.
  - 9) Brick, architectural concrete, cast stone, integrally colored plaster and stucco.
  - 10) Glass.
  - 11) Acoustical materials, unless specifically indicated.
  - 12) Concealed pipes, ducts, and conduits.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 05 50 00 - Metal Fabrications: Shop-primed items.
- C. Section 08 11 13 - Hollow Metal Doors and Frames: Shop-primed items.
- D. Section 08 14 16 - Flush Wood Doors: Staining of flush wood doors.
- E. Section 08 31 00 - Access Doors and Panels: Shop-primed items.
- F. Section 09 21 16 - Gypsum Board Assemblies: Painting of gypsum board surfaces.

#### **1.03 DEFINITIONS**

- A. Conform to ASTM D16 for interpretation of terms used in this section.

#### **1.04 REFERENCE STANDARDS**

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2014.
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 2007.
- D. SSPC-SP 1 - Solvent Cleaning; 2015.

#### **1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Color Schedule: The Architect will provide a color schedule to the Contractor after a paint manufacturer is selected and color chips have been submitted.
- C. Product Data: Provide complete list of products to be used, with the following information for each:
  - 1) Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
  - 2) MPI product number (e.g. MPI #47).
  - 3) Cross-reference to specified paint system(s) product is to be used in; include description of each system.
  - 4) Manufacturer's installation instructions.
- D. Samples: Submit two painted samples, illustrating selected colors for each color and system selected. Submit on paint suppliers standard sample material, 8" by 10" inch in size.
- E. Manufacturer's Instructions: Indicate special surface preparation procedures.
- F. Maintenance Materials: Furnish the following for the Owner's use in maintenance of the project.
  - 1) See Section 01 60 00 - 01 60 00, for additional provisions.
  - 2) Extra Paint and Finish Materials: 1 gallon of each color and type; from the same product run,.
  - 3) Label each container with color and color number or formula for each type in addition to the manufacturer's label.

#### **1.06 QUALITY ASSURANCE**

- A. Applicator Qualifications: Company specializing in performing painting on projects with the same type of material and extent of work as indicated for this project, and approved by manufacturer.
- B. Single-Source Responsibility: Provide primers and undercoat material produced by the same manufacturer as the finish coats for each type of coating. Use only thinners recommended by the manufacturer and only within recommended limits.
- C. Comply with EPA guidelines regarding paints formulated with any of the following ingredients, in any amount:
  - 1) Red lead.
  - 2) Basic lead silico chromate.
  - 3) Zinc chromate.
  - 4) Lead driers.

#### **1.07 MATERIAL QUALITY**

- A. All products not specified by name shall be "best grade" or "first line" products of acceptable manufacturers. See Part 3 Execution for materials required for this project. Where possible, materials shall be of a single manufacturer. Paint material containers not displaying manufacturer's product identification will not be acceptable.
- B. Proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude equal products of other manufacturers

#### **1.08 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.



- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.
- D. Storage and Mixing: Painter will be assigned a room or space in which to mix or store material. Provide galvanized mixing pans for this paint room or space in which paints shall be mixed. No mixing of paint shall be done except in these pans. Empty containers bearing the name or brand of any manufacturer shall not be brought upon the premises for mixing of paint unless labels are canceled and containers are closely marked as to contents.

### **1.09 FIELD CONDITIONS**

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply materials when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above the dew point; or to damp or wet surfaces.
- D. Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Provide paints and finishes from the same manufacturer.
  - 1) In the event that a single manufacturer cannot provide specified products, minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
- B. Paints:
  - 1) Benjamin Moore & Co.
  - 2) Diamond Vogel Paints.
  - 3) Glidden Professional, a product of PPG Architectural Coatings.
  - 4) Kwal Paint.
  - 5) PPG Paints.
  - 6) Sherwin-Williams Company.
- C. Transparent Finishes:
  - 1) Sherwin-Williams Company.
- D. Stains:
  - 1) Benjamin Moore.
  - 2) Sherwin-Williams Company.
  - 3) Olympic.
  - 4) Rez.
  - 5) Minwax.
- E. Primer Sealers: Same manufacturer as top coats.
- F. Block Fillers: Same manufacturer as top coats.
- G. Substitutions: See Section 01 60 00 - 01 60 00.

### **2.02 PAINTS AND FINISHES - GENERAL**

- A. Paints and Finishes: Ready mixed, unless intended to be a field-catalyzed paint.

- 1) Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
  - 2) Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
  - 3) For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
  - 4) Supply each paint material in quantity required to complete entire project's work from a single production run.
  - 5) Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content:
- 1) Provide paints and finishes that comply with the most stringent requirements specified in the following:
    - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
  - 2) Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
- C. Flammability: Comply with applicable code for surface burning characteristics.
- D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- E. Colors: To be selected from manufacturer's full range of available colors.
- 1) Selection to be made by Architect after award of contract.

### **2.03 ACCESSORY MATERIALS**

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
  - 1) Gypsum Wallboard: 12 percent.
  - 2) Plaster and Stucco: 12 percent.
  - 3) Masonry, Concrete, and Concrete Masonry Units : 12 percent.
  - 4) Interior Wood: 15 percent, measured in accordance with ASTM D4442.
  - 5) Concrete Floors and Traffic Surfaces: as noted in sections of floor coverings at concrete floor.

- F. Coordinating Work: Review sections in which other coatings are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on the characteristics of specified finish materials to ensure compatible primers.
  - 1) Notify the Architect of problems anticipated using the coatings specified over substrates primed by others.

### **3.02 PREPARATION**

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Masonry:
  - 1) Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
- F. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- G. Plaster: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- H. Ferrous Metal:
  - 1) Solvent clean according to SSPC-SP1.
  - 2) Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- I. Wood Surfaces to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.
- J. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

### **3.03 APPLICATION**

- A. Protection: Furnish and lay drop cloths or mask off areas where finishing is being done to protect floors and other work from damage during the execution of work. Where it becomes necessary to remove temporary coverings place by others, replace same in proper manner. Remove oily rags and waste from the building every night. Do not allow to accumulate.
- B. Apply products in accordance with manufacturer's written instructions.
- C. Paint metal door lites in wood doors to match color of frame unless otherwise indicated.
- D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- E. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- F. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- G. Sand wood and metal surfaces lightly between coats to achieve required finish.

- H. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- I. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- J. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

### 3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Final Clean-Up: At the completion of work, remove all surplus materials, staging, rubbish; clean off all paint from floors, glass, walls, hardware; and leave the premises in clean condition.

### 3.05 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

### 3.06 SCHEDULE - PAINT SYSTEMS

- A. Concrete - Painted:
  - 1) First Coat                      Block Filler
  - 2) Second Coat                  Acrylic Latex, Semi-Gloss
  - 3) Third Coat                     Acrylic Latex, Semi-Gloss
  - 4) Note: Back-roll or brush block filler to fill all voids.
- B. Precast - Painted:
  - 1) First Coat                      Block Filler
  - 2) Second Coat                  Acrylic Latex, Semi-Gloss
  - 3) Third Coat                     Acrylic Latex, Semi-Gloss
  - 4) Note: Back-roll or brush block filler to fill all voids.
- C. Masonry - Painted:
  - 1) First Coat                      Block Filler
  - 2) Second Coat                  Acrylic Latex, Semi-Gloss
  - 3) Third Coat                     Acrylic Latex, Semi-Gloss
  - 4) Note: Back-roll or brush block filler to fill all voids.
- D. Gypsum Board: Finish all surfaces exposed to view. Zero VOC, AnitMicrobial Coatings.
  - 1) First Coat                      Suitable Primer.
  - 2) Second Coat                  Acrylic Latex, Walls Semi-Gloss, Ceiling Eggshell
  - 3) Third Coat                     Acrylic Latex, Walls Semi-Gloss, Ceiling Eggshell
- E. Wood: Finish all surfaces exposed to view. Stained.
  - 1) First Coat                      Sanding Sealer For Natural Finish, Semi-Gloss
  - 2) Second Coat                  Polyurethane Varnish, Semi-Gloss
  - 3) Third Coat                     Polyurethane Varnish, Semi-Gloss
  - 4) Sand with No. 00 sandpaper between coats.
- F. Wood: Finish all surfaces exposed to view. Painted.
  - 1) First Coat                      Suitable Primer
  - 2) Second Coat                  Acrylic Latex, Semi-Gloss
  - 3) Third Coat                     Acrylic Latex, Semi-Gloss
- G. Wood Doors: Factory-finished.
- H. Steel Doors and Frames: Finish all surfaces exposed to view.

- 1) First Coat Suitable Primer if not already prime painted.
  - 2) Second Coat DTM Alkyd Enamel, Semi-Gloss
  - 3) Third Coat DTM Alkyd Enamel, Semi-Gloss
- I. Steel Fabrications: Finish all surfaces exposed to view.
- 1) First Coat Suitable Primer if not already prime painted.
  - 2) Second Coat DTM Alkyd Enamel, Semi-Gloss
  - 3) Third Coat DTM Alkyd Enamel, Semi-Gloss
- J. Galvanized Steel: Finish all surfaces exposed to view.
- 1) First Coat Suitable Primer
  - 2) Second Coat DTM Alkyd Enamel, Semi-Gloss
  - 3) Third Coat DTM Alkyd Enamel, Semi-Gloss
  - 4) Note: Omit primer for factory primed surfaces
- K. Wet Areas (showers, etc.) - Painted:
- 1) First Coat Suitable Primer, (per manufacturer's written instructions)
  - 2) Second Coat Pre-catalyzed Water Based Epoxy, Walls Semi-Gloss, Ceilings Eggshell
  - 3) Third Coat Pre-catalyzed Water Based Epoxy, Walls Semi-Gloss, Ceilings Eggshell
- L. Shop-Primed Metal Items: Finish surfaces exposed to view.
- 1) Finish the following items:
    - a. Elevator pit ladders.
    - b. Exposed surfaces of steel stairs and railings.
    - c. First Coat Suitable Primer if not already prime painted.
    - d. Second Coat DTM Alkyd Enamel, Semi-Gloss
    - e. Third Coat DTM Alkyd Enamel, Semi-Gloss
- M. Exposed Structure Ceilings to be Painted:
- 1) Spray paint all exposed deck, structural steel, joists, conduit, ducts, registers, mechanical units, piping, insulation, light fixture hangers (if not factory finished), speaker housings (if not factory finished), etc as follows:
  - 2) First Coat Primer as recommended by manufacturer
  - 3) Second Coat Water Based Dry Fall, Flat

**END OF SECTION**



## **SECTION 10 14 00 SIGNAGE**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Room and door signs.
- B. Traffic signs.

#### **1.02 REFERENCE STANDARDS**

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- C. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2009.

#### **1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
- C. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
  - 1) When room numbers to appear on signs differ from those on the drawings, include the drawing room number on schedule.
  - 2) When content of signs is indicated to be determined later, request such information from UCCS through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
  - 3) Submit for approval by UCCS through Architect prior to fabrication.
- D. Shop Drawings:
  - 1) Submit shop drawings indicating location, and attachment method for each type of sign specified.
- E. Samples: Submit one sample of each type of sign, of size similar to that required for project, illustrating sign style, font, and method of attachment. The sign may be returned to the Contractor for installation in the project upon request.
- F. Certification: Provide Proofreader certification for braille recognized by the National Library Service for the Blind and Physically Handicapped, Library of Congress (NLS).
- G. Manufacturer's Installation Instructions: Include installation templates and attachment devices.
- H. Maintenance Materials: Furnish the following for UCCS's use in maintenance of project.
  - 1) See Section 01 60 00 - 01 60 00, for additional provisions.

#### **1.04 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.
- B. Fabricator / Installer Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and have a minimum of five years of experience in the fabrication and installation of the same type of signage as this project.

## **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Package signs as required to prevent damage before installation.
- B. Package room and door signs in sequential order of installation, labeled by floor or building.

## **1.06 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  - 1) Failures include, but are not limited to, the following:
    - a. Deterioration of finishes beyond normal weathering.
    - b. Deterioration of graphic image colors
    - c. Deterioration of sign lamination.
  - 2) Warranty Period: Five years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Flat Signs: Basis of Design:
  - 1) APCO: Arcadia Series 1000.
  - 2) Substitutions: Not permitted.

### **2.02 SIGNAGE APPLICATIONS**

- A. Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.
- B. Room and Door Signs:
  - 1) Service Rooms: Identify with room names and numbers to be determined later, not those shown on the drawings. Room names and numbers to be coordinated with UCCS project manager.
  - 2) Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", room numbers to be determined later, and braille. Coordinate graphic, text, and room numbers with UCCS project manager.
- C. Traffic Signs: Locate where indicated on the drawings.

### **2.03 SIGN TYPES**

- A. Size: Varies.
- B. Finish: Natural satin holder and caps.
- C. Mounting: Mechanically fasten.
- D. Lens: Upper-Clear lens. Lower-Clear 2" H photopolymer lens with tactile ADA compliant room numbers and braille.
- E. Inserts: Paper color - To be selected from manufacturer's full range of standard colors.
- F. Printing: UCCS logo, approved verbiage and horizontal rule line at junction of lenses.
- G. Mounting Height: 48" to bottom of the lowest line of text.

### **2.04 EXTERIOR SIGNAGE**

- A. Type: regulatory signs with engineer grade reflective sheeting.
- B. Material: Aluminum, 0.080 gauge with rounded corners.
- C. Baked-Enamel Finish: Apply baked enamel reflective paint complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.



- D. Quantity, Size, Color, and Message:
  - 1) Regulatory:
    - a. Size and Shape: As indicated on Contract Drawings.
    - b. Text: As indicated on Contract Drawings.
    - c. Lettering: As required by code or noted on Contract Drawings.
    - d. Lettering: Helvetica Medium.
    - e. Color: As noted on Contract Drawings.
- E. Installation:
  - 1) Regulatory:
    - a. Wall Mount: Attach with Manufacturer's standard noncorroding anchors for substrates encountered.
    - b. Post Mount: Attach sign to telescoping square tube sign post with Manufacturer's standard non-corroding fasteners. Peen thread to prevent nut from coming loose. Install post per Contract Drawings and per manufacturer's written instructions.

## **2.05 ACCESSORIES**

- A. Exposed Screws: Stainless steel.
- B. Sealant: Clear, polyurethane sealant.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install neatly, with horizontal edges level.
- C. Install at heights as specified or as indicated on Contract Drawings. Install interior and exterior signage to comply with ANSI 117.1.
- D. Locate signs where indicated:
  - 1) Install signs on walls where indicated on contract drawings. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door. Signage location to comply with ADA requirements. Coordinate location with Architect.
  - 2) Comply with sign manufacturer's written instructions except where more stringent requirements apply.
  - 3) If no location is indicated obtain UCCS's instructions.
- E. Protect from damage until Substantial Completion; repair or replace damage items.

### **3.02 CLEANING AND PROTECTION**

- A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

**END OF SECTION**



## **SECTION 10 21 13.13 METAL TOILET COMPARTMENTS**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Metal toilet compartments.
- B. Urinal screens.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 06 10 00 - Rough Carpentry: Blocking and supports.
- B. Section 10 28 00 - Toilet, Bath, and Laundry Accessories.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall, floor, and ceiling supports, door swings.
  - 1) Show locations of reinforcement and cutouts for compartment-mounted toilet accessories.
- C. Product Data: Provide data on panel construction, hardware, and accessories.
- D. Samples: Submit two samples of partition panels, 2x4 inch in size illustrating panel finish.
- E. Manufacturer's Installation Instructions: Indicate special procedures.
- F. Submit at End of Project:
  - 1) Hinges: One complete set for every five stalls installed.
  - 2) Screws and Bolts: One complete set for every five stalls installed.
  - 3) Latches and Strikes: One set for every five stalls.

#### **1.05 FIELD CONDITIONS**

- A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Metal Toilet Compartments:
  - 1) Accurate Partitions Corporation.
  - 2) Bobrick Washroom Equipment, Inc.
  - 3) General Partitions Mfg. Corp.
  - 4) Global Steel Products Corp.
  - 5) Hadrian.
  - 6) Santana Products Co.
  - 7) Sanymetal Products Co.
  - 8) Substitutions: Section 01 60 00 - 01 60 00.

#### **2.02 MATERIALS**

- A. Stainless Steel Sheet: ASTM A666, Type 304.

## 2.03 COMPONENTS

- A. Toilet Compartments: Stainless steel, floor-mounted headrail-braced.
- B. Doors, Panels, and Pilasters: Sheet steel faces, pressure bonded to sound deadening core, formed and closed edges; corners made with corner clips or mitered, welded, and ground smooth.
  - 1) Panel Faces: 20 gage, 0.0359 inch.
  - 2) Door Faces: 22 gage, 0.0299 inch.
  - 3) Pilaster Faces: 18 gage, 0.0478 inch.
  - 4) Reinforcement: 12 gage, 0.1046 inch.
  - 5) Internal Reinforcement: Provide in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted washroom accessories.
- C. Door and Panel Dimensions:
  - 1) Thickness: 1 inch.
  - 2) Door Width: 24 inch.
  - 3) Door Width for Handicapped Use: 36 inch, out-swinging.
  - 4) Height: 58 inch.
- D. Pilasters: 1-1/4 inch thick, of sizes required to suit compartment width and spacing.
- E. Urinal Screen Splash Panels: Stainless steel sheet 30 inch wide by 42 inch high mounted on partitions adjacent to urinals. Fasten with stainless steel screws spaced 8 inches on center.

## 2.04 ACCESSORIES

- A. Pilaster Shoes: Formed ASTM A666, Type 304 stainless steel with No. 4 finish, 3 inch high, concealing floor fastenings.
  - 1) Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
  - 2) Provide ceiling attachment using two adjustable hanging studs, attached to above-ceiling framing.
- B. Head Rails: Hollow stainless steel tube, 1 by 1-5/8 inch size, with anti-grip strips and cast socket wall brackets.
- C. Brackets: Satin stainless steel.
- D. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
  - 1) For attaching panels and pilasters to brackets: Through-bolts and nuts; tamper proof.
- E. Hardware: Polished stainless steel:
  - 1) Pivot hinges, gravity type, adjustable for door close positioning; two per door.
  - 2) Thumb turn or sliding door latch with exterior emergency access feature.
  - 3) Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
  - 4) Coat hook with rubber bumper; one per compartment, mounted on door. Coat hook to be installed per ADA requirements at handicap stalls.
  - 5) Provide door pull on each side of doors to handicap compartments.

## 2.05 FINISHING

- A. Stainless Steel Compartments: No. 4 finish.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify existing conditions before starting work.

- B. Verify that field measurements are as indicated on shop drawings.
- C. Verify correct spacing of and between plumbing fixtures.
- D. Verify correct location of built-in framing, anchorage, and bracing.

### **3.02 INSTALLATION**

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 to 1/2 inch space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.
- E. Overhead-Braced-and-Floor-Anchored Compartments: Secure pilasters to floor and level, plumb, and tighten installation with devices furnished. Secure overhead brace to each pilaster with not less than two fasteners. Hang doors and adjust so that tops of doors are parallel with overhead brace when doors are in closed position.
- F. Field touch-up of scratches will not be permitted. Replace damaged or scratched materials with new materials.

### **3.03 TOLERANCES**

- A. Maximum Variation From True Position: 1/4 inch.
- B. Maximum Variation From Plumb: 1/8 inch.

### **3.04 ADJUSTING**

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
- B. Adjust hinges to position doors in partial opening position, 30 degrees, when unlatched. Return out swinging doors to closed position.
- C. Adjust adjacent components for consistency of line or plane.

**END OF SECTION**



## **SECTION 10 28 00**

### **TOILET, BATH, AND LAUNDRY ACCESSORIES**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Accessories for toilet rooms and utility rooms.
- B. Electric hand/hair dryers.
- C. Grab bars.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 05 50 00 - Metal Fabrications: Sheet metal blocking.
- B. Section 06 10 00 - Rough Carpentry: Wood blocking.
- C. Section 07 92 00 - Joint Sealants: Sealant around toilet accessories.
- D. Section 09 21 16 - Gypsum Board Assemblies.
- E. Section 09 30 00 - Tiling.
- F. Section 10 21 13.19 - Plastic Toilet Compartments.

##### **1.03 REFERENCE STANDARDS**

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- D. ASTM C1036 - Standard Specification for Flat Glass; 2011.
- E. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2012.

##### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
- C. Setting drawings where cutouts are required in other work, including templates, substrate preparation instructions, and directions for preparing cutouts and installing anchorage devices.
- D. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

##### **1.05 QUALITY ASSURANCE**

- A. Anchorages and Inserts: Furnish accessory manufacturer's standard inserts and anchoring devices that must be built into concrete walls. Coordinate delivery with other work to avoid delay.
- B. Single Source Responsibility:
  - 1) Provide products of the same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise approved by Architect.
  - 2) Provide products of the same manufacturer for each type of locker bench scheduled or specified unless otherwise approved by Architect.

## **1.06 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.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Do not install toilet room accessories until Work in spaces to receive them is clean, dry, and ready for accessory installation.
- B. Protect accessories from damage during delivery, handling, storage, and installation.
- C. Deliver master keys to Owner.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Toilet Accessories:
  - 1) As noted in Toilet Accessories Schedule
  - 2) Substitutions: Not permitted.
- B. Electric Hand/Hair Dryers:
  - 1) As noted in Toilet Accessories Schedule.
  - 2) Substitutions: Not permitted.
- C. All items of each type to be made by the same manufacturer.

### **2.02 MATERIALS**

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
  - 1) Grind welded joints smooth.
  - 2) Fabricate units made of metal sheet of seamless sheets, with flat surfaces.
- B. Keys: Provide three (3) keys for each accessory to UCCS; master key lockable accessories.
- C. Stainless Steel Sheet: ASTM A666, Type 304.
- D. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
- E. Mirror Glass: Tempered safety glass, ASTM C1048; and ASTM C1036 Type I, Class 1, Quality Q2, with silvering as required.
- F. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.
- G. Surface-Mounted Toilet Accessories, General: Except where otherwise indicated, fabricate units with tight seams and joints, exposed edges rolled. Hand doors or access panels with continuous stainless steel piano hinge. Provide anchorage that is fully concealed when unit is closed.
- H. Recessed Toilet Accessories, General: Except where otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors or access panels with full-length, stainless steel piano hinge. Provide anchorage that is fully concealed when unit is closed.

### **2.03 FINISHES**

- A. Stainless Steel: No. 4 Brushed finish, unless otherwise noted.
- B. Baked Enamel: Pretreat to clean condition, apply one coat primer and minimum two coats epoxy baked enamel.



## **2.04 TOILET ROOM ACCESSORIES**

- A. Refer to Toilet Accessories Schedule on Contract Drawings for toilet room and utility room accessories.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. Verify that field measurements are as indicated on drawings.
- D. See Section 05 50 00 and/or 06 10 00 for installation of blocking in walls.

### **3.02 PREPARATION**

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

### **3.03 INSTALLATION**

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on the drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Install grab bars to withstand a downward load of at least 250 lbf, complying with ASTM F 446.
- D. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
  - 1) Grab Bars: As indicated on the drawings.
  - 2) Other Accessories: As indicated on the drawings.

### **3.04 ADJUSTMENT**

- A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.
- B. Clean and polish all exposed surfaces strictly according to manufacturer's recommendations after removing temporary labels and protective coatings.

### **3.05 PROTECTION**

- A. Protect installed accessories from damage due to subsequent construction operations.

**END OF SECTION**



## **SECTION 10 44 00 FIRE PROTECTION SPECIALTIES**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 05 50 00 - Metal Fabrications: Sheet metal blocking.
- B. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 09 21 16 - Gypsum Board Assemblies: Roughed-in wall openings.

#### **1.03 REFERENCE STANDARDS**

- A. NFPA 10 - Standard for Portable Fire Extinguishers; 2013.
- B. NFPA No. 101 – Life Safety Code, latest edition.
- C. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product data for each type of fire extinguisher and cabinet specified.

#### **1.05 QUALITY ASSURANCE**

- A. Installer: The installer shall be experienced in the installation of portable fire and safety equipment, and shall be familiar with manufacturer's recommendations for installation of specific materials.
- B. Single-Source Responsibility: Obtain extinguishers and cabinets from one source from a single manufacturer.
- C. Coordination: Verify that cabinets are sized to accommodate type and capacity of extinguishers indicated. Verify that cabinets are sized to accommodate wall thickness.
- D. UL-Listed Products: Fire extinguishers shall be UL listed with UL.

#### **1.06 FIELD CONDITIONS**

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Fire Extinguishers:
  - 1) Nystrom, Inc.
  - 2) J.L. Industries.
  - 3) Larson's Manufacturing Company.
  - 4) Potter-Roemer.
  - 5) Substitutions: See Section 01 60 00 - 01 60 00.
- B. Fire Extinguisher Cabinets and Accessories:
  - 1) JL Industries, Inc.
  - 2) Larsen's Manufacturing Co.
  - 3) Nystrom, Inc.

- 4) Potter-Roemer.
- 5) Substitutions: See Section 01 60 00 - 01 60 00.

## **2.02 FIRE EXTINGUISHERS**

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
  - 1) Provide extinguishers labeled by UL (DIR) for the purpose specified and indicated.
- B. Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gage.
  - 1) Class: A:B:C.
  - 2) Size: 10 pound.
  - 3) Finish: Baked polyester powder coat, red color.

## **2.03 FIRE EXTINGUISHER CABINETS**

- A. Metal: Formed Aluminum.
- B. Provide fire rated cabinet at fire rated walls.
- C. Cabinet Configuration: Semi-recessed type.
  - 1) Sized to accommodate accessories.
  - 2) Rolled edges.
- D. Door: 0.036 inch thick, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with two butt hinge. Provide nylon catch.
- E. Door Glazing: Plastic, clear, 1/8 inch thick acrylic. Set in resilient channel gasket glazing.
- F. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.
- G. Weld, fill, and grind components smooth.
- H. Finish of Cabinet Exterior Trim and Door: Clear Aluminum.
- I. Finish of Cabinet Interior: Clear Aluminum.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

### **3.02 INSTALLATION**

- A. Maximum Distance to fire extinguishers: Per IBC standards utilized for project.
- B. Install in accordance with manufacturer's instructions.
- C. Install cabinets plumb and level in wall openings, 48" inches from finished floor to center of handle.
- D. Secure rigidly in place.
- E. Place extinguishers in cabinets.
- F. Install vertical lettering on door reading: FIRE EXTINGUISHER
  - 1) Color: Red

**END OF SECTION**

## **SECTION 12 32 16**

### **MANUFACTURED PLASTIC-LAMINATE-FACED CASEWORK**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Manufactured plastic-laminate-faced cabinet and shelving.
- B. Cabinet hardware.
- C. Factory finishing.
- D. Preparation for installing utilities.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 05 50 00 - Metal Fabrications. Sheet metal blocking.
- B. Section 06 10 00 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- C. Section 12 36 00 - Countertops.
- D. Section 07 92 00 - Joint Sealants.
- E. Section 09 21 16 - Gypsum Board Assemblies.
- F. Division 22 - Plumbing fixtures.

##### **1.03 REFERENCE STANDARDS**

- A. ANSI A208.2 - American National Standard for Medium Density Fiberboard for Interior Use; 2009.
- B. AWI (QCP) - Quality Certification Program, [www.awiqcp.org](http://www.awiqcp.org); current edition at [www.awiqcp.org](http://www.awiqcp.org).
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2009.
- D. BHMA A156.9 - American National Standard for Cabinet Hardware; Builders Hardware Manufacturers Association; 2010 (ANSI/BHMA A156.9).
- E. NEMA LD 3 - High-Pressure Decorative Laminates; National Electrical Manufacturers Association; 2005.

##### **1.04 IDENTIFICATIONS**

- A. Definitions: The following definitions apply to plastic-laminate-faced casework units:
  - 1) Exposed portions of casework include all surfaces visible when doors and drawers are closed and all visible members in open shelf cases.
  - 2) Semi-exposed portions of casework includes those members behind doors such as shelves, divisions, interior faces of ends, case back, drawer sides, backs and bottoms, and the back face of doors. Tops of cases 6'-6" or more above floor shall be considered as semi-exposed. All visible members behind glass doors also shall be considered as semi-exposed portions.
  - 3) Concealed portions of casework include sleepers, web frames, dust panels, and other surfaces not usually visible after installation.

##### **1.05 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
  - 1) Minimum Scale of Detail Drawings: 1-1/2 inch to 1 foot.
- C. Product Data:

- 1) Submit manufacturer's data and installation instructions for each type of plastic-laminate-faced casework unit.
  - 2) Provide data for hardware accessories.
- D. Samples for selection of the following in the form of manufacturer's color charts consisting of actual units or sections of units showing the full range of colors, textures, and patterns available for each type of material indicated.
- 1) Plastic laminates.
  - 2) PVC Edging.

#### **1.06 QUALITY ASSURANCE**

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum 10 years of experience with at least 5,000 lineal feet installed in the state in which the project is located.
- 1) Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Do not deliver casework until painting and similar operations that could damage, soil, or deteriorate casework have been completed in installation areas. If casework must be stored in other than installation areas, store only in areas whose environmental conditions meet requirements specified in Section 01 60 00, Product Requirements.

#### **1.08 FIELD CONDITIONS**

- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet-work is completed, and HVAC system is operating and will maintain temperature and relative humidity.
- B. Field Measurements: Where casework is indicated to be fitted to other construction, check actual dimensions of other construction by accurate field measurements before fabrication, and show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- 1) Verify locations of concealed framing, blocking, reinforcements, and furring that support casework by accurate field measurements before being enclosed. Record measurements on final shop drawings.
  - 2) Where field measurements cannot be made without delaying the Work, coordinate dimensions with General Contractor and proceed with fabricating casework without field measurements. Provide allowance for trimming at site and coordinate construction to ensure that actual dimensions correspond to shop dimensions.
- C. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

#### **1.09 COORDINATION**

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior casework can be supported and installed as indicated.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Concepts in Millwork, Inc..
- B. Cab-Con..
- C. LSI Corporation.
- D. TMI Systems Design Corp..

- E. Sidney Millwork..
- F. Salina Planning Mill.
- G. Substitutions: See Section 01 60 00 - 01 60 00.

## **2.02 CABINETS**

- A. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI//AWMAC/WI Architectural Woodwork Standards (AWS) for Custom Grade.
- B. Plastic Laminate Faced Cabinets: Custom grade.
- C. Cabinets :
  - 1) Finish - Exposed Exterior Surfaces: Decorative laminate.
  - 2) Finish - Exposed Interior Surfaces: Decorative laminate.
  - 3) Finish - Concealed Surfaces: Manufacturer's option.
  - 4) Finish - Semiexposed Surfaces: Provide surface materials indicated below:
    - a. Surfaces Other than Drawer Bodies: Thermoset decorative overlay.
    - b. Drawer Sides and Backs: Thermoset decorative overlay.
    - c. Drawer Bottoms: Thermoset decorative overlay.
    - d. Color: White
  - 5) Door and Drawer Front Edge Profiles: 3mm PVC.
    - a. PVC edge-banding must be applied with hot melt glue, no exceptions.
  - 6) Cabinet Body Front Edge Profile: 1mm PVC.
    - a. PVC edge-banding must be applied with hot melt glue, no exceptions.
  - 7) Cabinet Style: Flush overlay.
  - 8) Cabinet Doors and Drawer Fronts: Flush style.
  - 9) Drawer Side Construction: Multiple-dovetailed.
  - 10) Drawer Construction Technique: Dovetail joints.

## **2.03 WOOD-BASED COMPONENTS**

- A. Wood fabricated from old growth timber is not permitted.

## **2.04 LAMINATE MATERIALS**

- A. Manufacturers:
  - 1) Formica Corporation.
  - 2) Panolam Industries International, Inc\Nevamar.
  - 3) Wilsonart,LLC.
  - 4) Johnsonite.
  - 5) Pionite
  - 6) Substitutions: See Section 01 60 00 - 01 60 00.
- B. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.
- C. Provide specific types as follows:
  - 1) Horizontal Surfaces: HGS, 0.048 inch nominal thickness, colors as scheduled, finish as selected.
  - 2) Vertical Surfaces: VGS, 0.028 inch nominal thickness, colors as scheduled, finish as selected.
  - 3) Post-Formed Horizontal Surfaces: HGP, 0.039 inch nominal thickness, colors as scheduled, finish as selected.
  - 4) Post-Formed Vertical Surfaces: VGP, 0.028 inch nominal thickness, colors as scheduled, finish as selected.
  - 5) Cabinet Liner: CLS, 0.020 inch nominal thickness, colors as scheduled, finish as selected.

## **2.05 COUNTERTOPS**

- A. See Section 12 36 00, Countertops.

## **2.06 ACCESSORIES**

- A. Adhesive: Urea-formaldehyde.
- B. Fasteners: Size and type to suit application.
- C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized finish in concealed locations and stainless steel finish in exposed locations.
- D. Concealed Joint Fasteners: Threaded steel.

## **2.07 HARDWARE**

- A. Hardware: BHMA A156.9, types as scheduled for quality grade specified.
- B. Cabinet Hardware Schedule: Refer to schedule at end of this Section for cabinet hardware required for architectural cabinets.
- C. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA code number indicated.
  - 1) Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
- D. For concealed hardware provide manufacturer's standard finish that complies with product class requirements of BHMA A156.9.

## **2.08 FABRICATION**

- A. General: Fabricate plastic laminate-faced casework to dimensions, profiles and details shown. Assemble units in the shop in as large of components as practicable to minimize field cutting and jointing. All joints to be dowelled and glued.
- B. Cabinet Joinery: Tops and bottoms shall be joined to cabinet ends using a minimum of six (6) dowels for 24" deep cabinets and a minimum of four (4) dowels for 12" deep cabinets. All dowels are to be hardwood laterally fluted, with chamfered end and a minimum diameter of ten millimeters. Dowels with less than 10 mm diameter are not acceptable. Internal cabinet components such as fixed horizontals, rails and verticals are to be doweled in place. Dowels are to be securely glued and cabinets clamped under pressure during assembly to assure secure joints and cabinet squareness.
- C. Bases: All base units shall have a separate factory applied base. Provide a plastic laminate base for each base cabinet.
- D. Cabinet Top and Bottom: Full sub-tops (rails not acceptable) and bottoms shall be particle board, 3/4" thick, laminated on the interior with low pressure laminate cabinet liner with a backer sheet of a neutral color on the unexposed surface. The interior surface of sink cabinet bottoms shall be laminated with high pressure laminate cabinet liner. The bottom surface of all upper cabinets shall be low pressure laminate cabinet liner. Front edges to be PVC edging (laminated not acceptable). All tops shall be solid except for sink base tops which shall have a 1" x 1" x 1/8" angle iron front rail. All cabinets over 42" and up to 72" in height shall be supplied with a finished 3/4" continuous top.
- E. Cabinet Ends: Unexposed cabinet ends shall be particle board, 3/4" thick, laminated on the interior with low pressure laminate cabinet liner and a backer sheet of a neutral color on the exterior unexposed surface. Exposed cabinet ends shall be laminated with vertical surface cabinet liner, Frosty White, Light Beige, or Dove Grey color, on the interior. Holes shall be drilled for adjustable shelf clips 32 mm (1-1/4") on center. Front edges to be banded with PVC edging (laminated not acceptable). Ends to be bored



to accept doweled top and bottom. All ends to be rabbeted to accept recessed back.

- F. Fixed Intermediate and Adjustable Shelves: Particle board, 3/4" thick, laminated on both sides with low pressure laminate cabinet liner (closed door cabinets). Color shall be Frosty White, Light Beige, or Dove Grey on both surfaces. Color as selected by Architect. Front edges to be banded with 3mm PVC edging. Shelves wider than 30" are 1" thick. Open shelf unit cabinet shelves to be laminated with high pressure decorative laminate. The widest adjustable shelf without intermediate supports is 36". Fixed shelves may span up to 48".
- G. Cabinet Back: Standard recessed cabinet back to be 1/4" thick prefinished hardboard. Color to match cabinet interior. All sink cabinets to have split back, removable from inside. Exposed exterior back on fixed or movable cabinets to be particle board, 3/4" thick, laminated with high pressure laminate on the exterior surface and Frosty White, Light Beige, or Dove Grey colored high pressure laminate cabinet liner on the interior surface. Interior back surface on open wall cabinets to be high pressure decorative laminate.
- H. Cabinet Doors and Drawer Fronts: Particle board, 3/4" thick, shall be laminated with vertical surface high pressure laminate on the exposed surface and Frosty White, Light Beige, or Dove Grey colored high pressure laminate cabinet liner on the interior surface. Door and drawer edges to be banded with three (3) mm PVC edge banding, hot melt glue applied. Double doors shall be used on all cabinets in excess of 24" in width.
- I. Drawers: Sides, back, subfront, and bottom shall be particle board, 1/2" thick, laminated with White, Light Beige or Dove Grey colored melamine laminate. The back and subfront shall be dowelled and glued into the sides. No staples or nails permitted. Dowels shall be spaced 32 mm (1-1/4"). Dowels to be hardwood, laterally fluted, with chamfered ends and a minimum diameter of eight (8) millimeters. Top edge to be banded with PVC edging. Paper storage drawers to be heavy duty 3/4" particle board construction with 100 pound full extension slides, plywood reinforcement stiffener at bottom and a retaining hood at the rear of each drawer. Rabbet or tongue and groove construction.
- J. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- K. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- L. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- M. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners.
  - 1) Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify adequacy of backing and support framing.
- B. Verify location and sizes of utility rough-in associated with work of this section.
- C. Report any unsatisfactory conditions to the General Contractor in writing with copy to Architect.

### **3.02 PREPARATION**

- A. Field Measurements: Field measure spaces to receive casework before beginning fabrication.
- B. Condition casework to average prevailing humidity conditions in installation areas before installing.
- C. Before installing architectural casework, examine shop-fabricated work for completion and complete work as required, including back priming and removal of packing.

### **3.03 INSTALLATION**

- A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- B. Cabinets: Install without distortion so that doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated.
  - 1) Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
- C. Use fixture attachments in concealed locations for wall mounted components.
- D. Use concealed joint fasteners to align and secure adjoining cabinet units.
- E. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
- F. Tops: Anchor securely to base units and other support systems as indicated and coordinated on approved shop drawings and detailed. Provide sealant at space between backsplash and wall with specified sealant.
  - 1) Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.

### **3.04 ADJUSTING**

- A. Adjust installed work.
- B. Adjust moving or operating parts to function smoothly and correctly.

### **3.05 CLEANING**

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

### **3.06 PROTECTION**

- A. Provide final protection and maintain conditions in a manner acceptable to fabricator and Installer that ensures that casework is without damage or deterioration at the time of Substantial Completion.

### **3.07 HARDWARE AND ACCESSORY ITEMS**

- A. Hinges: Blum B73T558 120 Degree metal hinge. Nickel-plated.
- B. Door and Drawer Pulls: EPCO 4" wire pull MC402-4-BRC. Brushed Chrome.
- C. Drawer Suspensions: Typical Drawers: Drawer suspensions shall be Accuride 3832 Heavy Duty Telescoping Drawer Slide. Slides will have a 100-pound load rating at full extension and a built-in, positive stop both directions, and shall be self-closing. Slides shall have a lifetime warranty as offered by the slide manufacturer.
- D. Catches:
  - 1) Magnetic catch with a minimum ten (10) pound pull per door, attached with screws and slotted for adjustment. Mount magnets at the top and bottom of each door.

- 2) Cast aluminum elbow catch. Plate size to be 1 3/8" L x 5/8" H. Use at inactive leaf of double door.
- E. Shelf Supports: Friction fit, two (2) pin, self locking shelf support adjustable 32 mm o.c. Locks in place 3/4" or 1" thick shelves. Structural load of 300 lbs. per clip.
- F. Door and Drawer Locks: Five (5) disc tumbler, cam type, keyed alike or differently as required by Owner and mastered keyed. Each lock shall be furnished with two keys. Fifty (50) lock changes available. Coordinate keying with the Owner. Locks as noted on Contract Drawings.

**END OF SECTION**



## **SECTION 12 36 00 COUNTERTOPS**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Countertops for manufactured casework.
- B. Wall-hung counters and vanity tops.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 12 32 16 - Manufactured Plastic-Laminate-Faced Casework.
- B. Section 22 40 00 - Plumbing Fixtures: Sinks.

#### **1.03 REFERENCE STANDARDS**

- A. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. 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) Specimen warranty.
- C. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections.
- D. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.
- E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.
- F. Installation Instructions: Manufacturer's installation instructions and recommendations.
- G. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

#### **1.05 QUALITY ASSURANCE**

- A. Fabricator Qualifications: Same fabricator as for cabinets on which tops are to be installed.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

### **PART 2 PRODUCTS**

#### **2.01 COUNTERTOPS**

- A. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
  - 1) Flat Sheet Thickness: 1/2 inch, minimum.
  - 2) Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.

- a. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
  - b. Color and Pattern: As selected by Architect from manufacturer's full line.
  - c. Manufacturers:
    - 1) Avonite Surfaces.
    - 2) Dupont.
    - 3) Formica Corporation.
    - 4) Wilsonart, LLC.
  - 3) Other Components Thickness: 1/2 inch, minimum.
  - 4) Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; radiused edge.
  - 5) Back and End Splashes: Same sheet material, radiused top; minimum 4 inches high.
- B. Exposed Edge at Openings in Counter: Bullnose edge.
  - C. Sinks: Provide cutouts for sinks as required. Coordinate with Division 22 - Plumbing Contract Drawings.
  - D. Additional work:
    - 1) Skirts: As indicated on drawings.

## **2.02 ACCESSORY MATERIALS**

- A. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- B. Support Brackets: For countertops without a base cabinet support and where indicated on contract drawings. A&M Hardware, Inc. work station bracket. Size as required to support full depth of countertop. Color as selected by Architect from manufacturer's full range of standard colors.
- C. Joint Sealant: Mildew-resistant silicone sealant, clear.

## **2.03 FABRICATION**

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
  - 1) Join lengths of tops using best method recommended by manufacturer.
  - 2) Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
  - 3) Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
  - 1) Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
  - 2) Height: 4 inches, unless otherwise indicated.
- C. Solid Surfacing: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
- D. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.

## **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.

- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

### **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. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B. Seal joint between back/end splashes and vertical surfaces.

### **3.04 CLEANING**

- A. Clean countertops surfaces thoroughly.

### **3.05 PROTECTION**

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

**END OF SECTION**





## **SECTION 12 48 13**

### **ENTRANCE FLOOR MATS AND FRAMES**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Surface applied entrance mat.

##### **1.02 SUBMITTALS**

- A. See Section 01 33 00 - Submittal Procedures: Submittal requirements.
- B. Product Data: Provide data indicating properties of mat surface, component dimensions.
- C. Shop Drawings: Indicate dimensions.
- D. Samples: Submit two samples, 12"x12" inch minimum in size illustrating pattern, color, finish, edging .
- E. Maintenance Data: Include cleaning instructions, stain removal procedures.

##### **1.03 QUALITY ASSURANCE**

- A. Accessibility Requirements: Provide installed floor mats that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)," and Sections 302 and 303 in ICC A117.1.

#### **PART 2 PRODUCTS**

##### **2.01 MANUFACTURERS**

- A. Floor Mats:
  - 1) American Floor Products Company, Inc.
  - 2) Nystrom, Inc.
  - 3) R.C. Musson Rubber Co.
  - 4) Pawling Corporation.
  - 5) Substitutions: See Section 01 60 00 - 01 60 00.

##### **2.02 MATS**

- A. Polypropylene Mat:
  - 1) Surface:
    - a. Fiber Type: Solution dyed Polypropylene.
    - b. Weight: 24 oz/sqyd.
    - c. Nub Height: 1/4"
    - d. Design: As selected by architect from manufacturer's full range of standard patterns and colors.
  - 2) Backing
    - a. 100% SBR Rubber (20% recycled content)
    - b. Thickness: .110"-border, .190" - nubs, .050-between nubs
    - c. Durometer: 60
  - 3) Provide with water dam border around perimeter.
  - 4) Size: As noted on Contract Drawings.

##### **2.03 FABRICATION**

- A. Fabricate mats in single unit sizes; fabricate multiple mats where indicated.
- B. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed

manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install walk-off surface after cleaning of finish flooring.
- B. Install surface-type units to comply with manufacturer's written instructions at locations indicated; coordinate with entrance locations and traffic patterns.

**END OF SECTION**

**SECTION 21 05 00**  
**COMMON WORK REQUIREMENTS FOR FIRE SUPPRESSION**

**PART 1 GENERAL**

**1.01 SCOPE OF WORK**

A. See Division 23, Section 23 05 00, for applicable requirements.

**PART 2 PRODUCTS**

See Division 23, Section 23 05 00, for applicable requirements.

**PART 3 EXECUTION**

See Division 23, Section 23 05 00, for applicable requirements.

**END OF SECTION**



**SECTION 21 05 01**  
**DEMOLITION FOR FIRE SUPPRESSION**

**PART 1 GENERAL**

**1.01 REQUIREMENTS**

- A. Conform to applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

**1.02 RELATED SECTIONS**

- A. Section 22 05 00 for Common Work Requirements for Fire Suppression.
- B. Division 1 for Cutting and Patching.

**1.03 SCOPE OF WORK**

- A. The terms "demolish" and "remove" shall mean disconnect, cart away, and dispose of off site. Components to be demolished or removed include all materials, equipment, building construction, and other components as indicated. Components to be demolished shall become the property of the contractor, and contractor may dispose of them by either landfilling or by selling salvageable parts and recyclable materials to legitimate third parties.
- B. Except as specifically noted, asbestos abatement will be by others, and is not included in this contract. Advise Owner sufficiently in advance of demolition work so that Owner may arrange to have asbestos removed without delaying demolition or construction work.
- C. The Owner retains the first right of refusal on all components to be removed. When requested, remove components carefully and deposit components in locations as directed by the Owner.

**PART 2 PRODUCTS**

Not Applicable.

**PART 3 EXECUTION**

See Division 23, Section 23 05 01 for applicable requirements.

**END OF SECTION**



**SECTION 21 05 03**  
**TRENCHING AND BACKFILLING FOR FIRE SUPPRESSION**

**PART 1 GENERAL**

**1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

**1.02 SCOPE OF WORK**

- A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Division 21.
- B. The Contractor shall provide the services of a qualified underground locator to field locate and mark all existing buried utility lines, public and private, piping, conduits, etc., within the required construction area prior to the start of any trenching or excavation work.

**1.03 SAFETY REGULATIONS**

- A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplemental General Conditions and Safety Requirements for this type of work.

**PART 2 PRODUCTS**

Not Applicable.

**PART 3 EXECUTION**

See Division 23, Section 23 05 03, for applicable requirements.

**END OF SECTION**





**SECTION 21 05 04**  
**PIPE AND PIPE FITTINGS FOR FIRE SUPPRESSION**

**PART 1 GENERAL**

**1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.
- B. Lead Ban: All piping, solder and flux used in the installation of piping systems furnished and installed under Division 21, shall be lead free. The term lead free is defined as pipe which does not contain more than 8.0% lead and solder and flux which does not contain more than 0.2% lead.

**1.02 RELATED SECTIONS**

- A. Section 21 05 00 for Common Work Requirements for Fire Suppression.

**1.03 SUBMITTAL DATA**

- A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

**PART 2 PRODUCTS**

See Division 21, Section 21 13 13 for applicable requirements.

**PART 3 EXECUTION**

See Division 21, Section 21 13 13, for applicable requirements.

**END OF SECTION**



## **SECTION 21 05 23**

### **VALVES FOR FIRE SUPPRESSION**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.
- B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.
- C. Lead Ban: Valves shall be lead free. The term lead free is defined as valves which do not contain more than 8.0% lead.

##### **1.02 RELATED SECTIONS**

- A. Section 21 05 00, Common Work Requirements for Fire Suppression.
- B. Section 21 05 23, Valve Identification for Fire Suppression.
- C. Section 21 05 04, Pipe and Pipe Fittings for Fire Suppression.
- D. Division 23 for Valves.

##### **1.03 SCOPE**

- A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

##### **1.04 VALVE REQUIREMENTS**

- A. All Fire Suppression system valves shall be UL Listed and FM Approved. See applicable fire suppression system specification sections for additional valve requirements, including hose threads, tamper switches, etc.
- B. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.
- C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Grinnell, Victaulic, Nibco, or Dezurik, or equivalent.

#### **PART 2 PRODUCTS**

- A. See Division 21, Section 21 13 13, for applicable requirements.

#### **PART 3 EXECUTION**

- A. See Division 21, Section 21 13 13, for applicable requirements.

**END OF SECTION**



## SECTION 21 05 49

### FIRE SUPPRESSION AND ELECTRICAL INSTALLATION COORDINATION

#### PART 1 GENERAL

##### 1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

##### 1.2 RELATED DIVISIONS AND SECTIONS

- A. Section 21 05 00, Common Work Results for Fire Suppression.  
B. Division 22 for Plumbing Systems.  
C. Division 26 for Electrical.  
D. Division 28 for Fire Alarm System.

##### 1.3 SCOPE

- A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.  
B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.  
C. Make all connections to motors and controls for equipment supplied and/or installed under Division 21 according to Table 1.

#### PART 2 PRODUCTS

Not Applicable.

#### PART 3 EXECUTION

##### 3.1 INSTALLATION

- A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

TABLE 1

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 21	Div. 21	Div. 26	Div. 21
Fire Alarm System & Interface w/Fire Suppression Systems		Div. 28	Div. 28	Div. 28	Div. 28
Fire Sprinkler System Control - Supervisory Panels & Devices, Including Tamper Switches & Flow Switches		Div. 21	Div. 21	N/A	Div. 28

#### TABLE NOTES:

1. Unless specified to be supplied with the equipment

**END OF SECTION**



## SECTION 21 13 13

### FIRE PROTECTION SYSTEM, AUTOMATIC WET-PIPE SPRINKLER

#### PART 1 GENERAL

##### 1.01 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplement General Conditions and the General Requirements.
- B. Division 3 for concrete work.
- C. Division 26 for electrical work and building fire alarm system.
- D. Architectural Sections of this Specification for required cutting, patching, painting, required in conjunction with the installation of the new sprinkler system within the existing facility.

##### 1.02 RELATED SECTIONS

Section 21 05 00	Common Work Requirements
Section 21 05 03	Trenching and Backfilling for Mechanical Systems
Section 21 05 04	Pipe and Pipe Fittings
Section 21 05 05	Piping Specialties
Section 21 05 23	Valves
Section 23 05 49	Fire Suppression and Electrical Installation Coordination

##### 1.03 SCOPE

- A. Criteria: This Section covers the requirements for furnishing the design, fabrication, installation, and acceptance testing of a complete automatic wet-pipe sprinkler system.
- B. Classification: In accordance with NFPA 13 and 101 requirements and recommendations.
- C. Scope of Work: Provide the design, materials, equipment, fabrication, installation, labor, and supervision necessary to install, disinfect, flush, test, and place into service a complete wet-pipe sprinkler system.
  - 1. Fully sprinkle the facility per NFPA-13, the International Building Code, International Fire Code, state and/or local Fire Marshal, and any specific requirements of the Owner's insurance underwriter.
- D. Components: Provide all piping, fittings, control valves, check valves, alarm valve (with trim), tamper switches, fire department connection, sprinkler heads, hangers, bracing, test and drain connections, zone flow switches, tamper switches, accessories and incidentals required for a complete installation in accordance with codes and standards referenced in this Section.
- E. Protect all fire lines subject to freezing in a manner approved by NFPA. Use anti-freeze loops only as approved by NFPA and the Local Fire Marshal and only with approved backflow protection in accordance with applicable building codes. Electric heat tape will not be permitted.
- F. Conform to the applicable provisions of NFPA Standards 13 and 101. Unless otherwise shown on the Drawings or specified, all materials and equipment used in the installation of the fire protection systems shall be listed in the UL Fire Protection Equipment Directory, and shall be the latest design of the manufacturer. All fire hoses, threads and adapters shall match the standards of the City of Colorado Springs

- G. Provide temporary fire protection within all areas of the building under construction as required by the building codes and the Fire Marshal.

#### **1.04 QUALITY ASSURANCE**

- A. All materials and equipment used in the installation of the fire protection systems shall be UL listed and/or FM approved for intended use, unless stated otherwise in these specifications.
- B. Contractor Qualifications: Contractor shall be experienced, licensed and regularly engaged in the design, fabrication, and installation of automatic fire protection sprinkler systems.
- C. Certification: Welders and brazers shall be qualified per the ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- D. Employ skilled craftspersons and provide proper supervision to ensure the work is erected in a proper manner. Coordinate the work with existing conditions and other disciplines. Visit the premises and thoroughly understand the details of the work and working conditions, and verify all dimensions in the field. If discrepancies are noted which require clarification of the design intent, submit RFIs prior to performing related work. Lay out all work in a manner to avoid all interferences.
- E. The drawings show only approximate building outlines and interior construction details as an aid in understanding the scope of work. Follow the drawings as closely as building construction and the work of other trades will permit. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing such fittings, traps, valves, and accessories as may be required to meet such conditions. Field verify all dimensions and conditions governing the work.
- F. Do not render inoperative any building system without prior approval. Coordinate necessary shutdowns through seven day advanced written notification.
- G. Coordinate all fire protection piping and sprinklers with the ceiling or roof materials, lighting, ductwork, conduits, piping, suspended equipment, structural, and other building obstructions to provide an installation in compliance with the appropriate building codes, and NFPA Standards.

#### **1.05 EXISTING CONDITIONS**

- A. Examine existing conditions and related work required for the design and installation of the fire suppression system.
- B. Perform all field tests and inspections as may be necessary to determine water flow, fire protection and pressure characteristics (static and residual pressure and residual flow) necessary for the design and installation of the fire protection system. Contact the water utility to determine whether they anticipate any degradation in the available water source. Prior to starting design, procurement, and installation, submit to the Owner and Engineer a written report documenting the results of this discussion with the water utility.

#### **1.06 INTERRUPTING SERVICES**

- A. Coordinate the installation of all work in order to minimize interference with the operation of existing building and mechanical, plumbing, fire protection and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtime. Requests for the interruption of existing services shall be



submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written approval.

- B. All work requiring deactivations of the existing fire protection systems for new connections, relocations, removals, etc, shall be carefully coordinated with the Owner and the Fire Marshal and shall be arranged to minimize system downtime. The Contractor shall provide for all additional costs, as may be required, for work during non-standard hours in order to provide interconnection and interface with the existing fire protection system in order to minimize system deactivation time.

#### **1.07 OPERATION PRIOR TO ACCEPTANCE**

- A. The Owner may wish to place portions of the fire suppression systems in service prior to substantial completion. In this case, a written agreement will be prepared establishing warranty and other responsibilities to the satisfaction of both parties.

#### **1.08 SUBMITTALS**

- A. See Division 1 and Section 21 0500 for general submittal requirements.
- B. Within 45 days after the contract is awarded, provide submittal data for the complete fire suppression system for review.
  - 1. Submit sprinkler system design drawings and hydraulic calculations to the Fire Marshal, the Building Department AHJ, and the Owner's Insurer for review, comment, and approval.
    - a. Drawings must be prepared by either a minimum Level 3 NICET Certified Technician, or a professional engineer.
    - b. Drawings must be stamped by a professional engineer registered in fire protection.
  - 2. Upon receipt of stamped and approved system design drawings and hydraulic calculations from the Fire Marshal, the Building Department AHJ, and the Owner's Insurer, submit required sets of complete submittal data to the Architect as per spec Section 21 0500.
- C. Submit complete data describing all equipment and materials to be furnished including performance, quality, dimensions, and certifications of approving agencies. Include plans showing location and arrangement of water supply connection, control valve, fire department connections, alarm bells, tamper switches, on-site fire main routing, on-site fire hydrants and other equipment to be used; and including head layouts coordinated with lighting, plumbing and air conditioning systems. Submittals shall include the following:
  - 1. Shop drawings.
  - 2. Certifications (after installation and tests are completed).
  - 3. Equipment list.
  - 4. Material list.
  - 5. Installation instructions.
  - 6. Maintenance instructions.
  - 7. Operating instructions.
  - 8. Samples, colors.
  - 9. Welder's certification.

10. Catalog data (appropriate unit identified on cut).
  11. Recommended spare parts lists.
  12. Verifiable calculations.
  13. Nameplate data.
- D. Complete Package: Submit fire suppression work as a complete package to permit analysis of the system(s) and its components. Partial submittals will not be accepted.
- E. Hydraulic Calculations: Submit computerized hydraulic calculations. Maintain a minimum of 10 percent, but not less than a 5 psi buffer below the final water supply curve after accounting for required hose streams, pipe friction elevation differences, etc. Hydraulic design sprinkler system shall be in accordance with the following:
1. Sprinkler System Occupancy Hazard Classifications:
    - a. Office and Public Areas: Light Hazard
    - b. Storage Areas: Ordinary Hazard
    - c. Equipment Rooms: Ordinary Hazard
    - d. Service Areas: Ordinary Hazard
  2. Minimum Density Requirements for Automatic Sprinkler Hydraulic Design:
    - a. Light Hazard Occupancy: 0.10 gpm over 1500 sf area.
    - b. Ordinary Hazard, Group 1 Occupancy: 0.15 gpm over 1500 sf area.
    - c. Ordinary Hazard, Group 2 Occupancy: 0.20 gpm over 1500 sf area.
    - d. Special Occupancy Hazard: As determined by authority having jurisdiction.
- F. Shop Drawings: Minimum 1/8" = 1'0" for plans, and 1/4" = 1'0" for details, with minimum 3/16 inch lettering. Show all piping, sprinklers, hangers, flexible couplings, roof construction, electro-mechanical devices, and occupancy of each area, including ceiling and roof heights as required by NFPA 13. Show hydraulic reference points and remote areas.
- G. Record Drawings: Indicate any special systems or devices such as dry pendant heads, antifreeze loops, inspector's test connections, etc. Submit record drawings prior to requesting final payment.

#### **1.09 PRODUCT HANDLING**

- A. Materials and Equipment: Protect materials and equipment from damage during shipping, storage, and installation.
- B. Materials and Equipment Installation: Ensure materials and equipment are free of moisture, scale, corrosion, dirt, and other foreign materials prior to installation.
- C. Plugs and Cover Plates: Protect flanged openings with gasketed metal cover plates to prevent damage during shipment. Cap or plug all drains, vents, and small piping or gauge connections.
- D. Sprinkler Head Protection: Remove frangible bulb protectors after sprinkler heads are installed. Protect sprinkler heads with factory-supplied caps and covers until ceiling installation is complete.

#### **1.10 ENVIRONMENTAL CONDITIONS**

- A. The sprinkler system and system components shall be designed to operate at an elevation of 6180 feet above sea level.

### **1.11 ALARM FACILITIES**

- A. Provide water flow switches and tamper switches. Integrate these and other required sprinkler system alarm devices into the building fire alarm system provided under Division 26. Coordinate with Division 26, Fire Detection and Alarm, regarding the requirements and location of items provided under this section which must be integrated with the fire alarm system.
- B. Provide tamper switches on all required valves and devices, both new and existing, used in conjunction with the building fire protection system.

### **1.12 ELECTRICAL CONNECTIONS**

- A. The fire alarm system will monitor waterflow indicators, tamper switches, etc., provided under this Section.

### **1.13 EXISTING EQUIPMENT**

- A. Reuse existing fire protection system equipment and devices including sprinkler heads, alarm valves, flow switches, valves, etc., as indicated. Re-use of existing equipment and devices shall in no way diminish or reduce the Contractor's one-year warranty for the complete fire protection system.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. All material and equipment furnished shall be in accordance with the following requirements and NFPA 13. All fire protection materials and equipment shall be new and unused, shall be free of defects and specifically designed for the use intended, shall conform to the requirements of NFPA 13, and shall be UL listed and FM approved, unless otherwise noted in the Specification.
- B. Any deviation to the above requirements shall be submitted to the Architect for approval. The deviation submittal shall be clearly identified as a "deviation." The Contractor shall clearly identify all existing equipment and devices proposed for re-use.

### **2.02 PIPING MATERIAL**

- A. Material Requirement: Automatic sprinkler piping shall be in accordance with this Section and NFPA 13, respectively.
- B. Underground piping within the building and to a point 5'0" from the building perimeter shall be AWWA Class 200 ductile iron water main pipe and fittings with mechanical joints. Interior of pipe and fittings shall be cement lined. Exterior of pipe and fittings shall be bituminous coating or equivalent. All changes in direction shall be adequately blocked or strapped to prevent separation of joints.
- C. Interior building piping systems shall be black steel pipe ASTM A120, or A53 Grade A or B, ERWQ or BW, Standard wall, Schedule 40. UL and FM approved thin wall (Schedule 10, minimum) ASTM A135 or A795 piping may be utilized for sprinkler system as allowed by NFPA and the Fire Marshal. Piping installed outside or exposed to outdoor ambient conditions shall be galvanized.

### **2.03 FITTINGS**

- A. Changes of direction shall be accomplished by the use of fittings suitable for use in sprinkler systems as defined in Article 3-13 of NFPA 13. Fittings installed outside or exposed to outdoor ambient conditions shall be galvanized.

- B. Fittings and specials for ductile iron pipe shall be Class 250 to match pipe, conforming to AWWA C110, mechanical flange joint type. All ductile iron fittings shall be cement lined.
- C. Fittings for steel pipe shall be cast iron screwed, welded fittings, or UL and FM approved mechanical pipe couplings and fittings as manufactured by Victaulic or equivalent in accordance with requirements specified in Section 21 05 04.

#### **2.04 JOINTS**

- A. Joints shall be provided in accordance with Section 21 05 04, Pipe and Pipe Fittings, and the manufacturer's instructions. Threaded joints for thin-wall (Schedule 10) piping shall be provided in strict accordance with NFPA requirements, UL and FM approvals for threadable thin-wall piping.

#### **2.05 UNIONS AND FLANGES**

- A. Unions and flanges shall be provided in accordance with Section 21 05 04, Pipe and Pipe Fittings. Gaskets shall be as recommended by the manufacturer and suitable for service on which used.

#### **2.06 HANGERS AND SUPPORTS**

- A. See Section 21 05 04, Pipe and Pipe Fittings, for general requirements associated with equipment piping systems hangers and supports. Seismic supports for fire protection system shall be provided in accordance with NFPA requirements.
- B. All fire protection piping shall be rigidly supported from the building structure by means of adjustable ring type hangers. Piping hangers shall be spaced as specified in NFPA 13, Chapter 2. Piping system shall be installed in an approved manner and shall not overload the structure. The Contractor shall provide additional hangers and steel support members as may be required to distribute the piping weight over several structural members where required or directed. Fire protection piping system shall be supported independent and shall not be attached or supported from hangers, trapezes, or supports provided for other piping systems or equipment.

#### **2.07 VALVES**

- A. See Section 21 0523, Valves, for general valve requirements. All valves for fire hose fire department connections shall have threads and adapters to match the standard of the City of Colorado Springs Fire Department. All valves shall be UL listed and FM approved. Valve sizes shall be determined by the approved hydraulic calculations. Outside screw and yoke valves shall be indicated on the approved hydraulic calculations. Tamper switches shall be provided on all valves controlling fire protection system operation, as required by NFPA, including existing valves retained and re-used in conjunction with the provision of the complete building fire protection system for the facility. Valves shall be rated for working pressure not less than the maximum pressure to be developed at that point in the system under any operating condition.
- B. Gate valves 2" and under, shall be bronze body and trim, outside screw and yoke, wedge disc, screwed connections, 400 psi W.O.G. maximum working pressure.
- C. Gate valves, 2-1/2" and larger, shall be Class 125 or Class 250, as required, with flanged ends, outside screw and yoke, bronze seals, wedge disc, iron body.
- D. Drain valves shall be globe valve or angle body globe valve, with screwed ends, bronze body and trim, 200 psig W.O.G. maximum working pressure. Furnish and install as required by NFPA No. 13.

- E. Swing check valves 2" and smaller shall be y-pattern, horizontal swing bronze body, bronze trim, 200 psig W.O.G. screwed connections.
- F. Swing check valves 2-1/2" and larger, shall be iron body, clearway swing check, Class 125 or Class 250 as required with flanged or grooved connections.
- G. Automatic Ball Drips: Automatic ball drips shall be 1/2" or 3/4" as required normally open, which close when the flow of water through the valve exceeds 4 to 10 gpm, 175 psig working pressure, Underwriters' Laboratories, Inc., or Factory Mutual approved, Standard Fire West No. 5248 or equivalent.

## **2.08 ALARM CHECK VALVES**

- A. Furnish complete wet-pipe sprinkler system alarm check valve assembly with all accessories required for system operation, supervision and alarm. Valves shall be UL listed and FM approved, designed to automatically activate electrically and/or hydraulically operated alarms and shall be furnished in the required size and arrangement with either flanged or grooved connections.
- B. Furnish retard chamber, pressure gauges, valves, and trim including water motor gong and alarm switch with both normally open and normally closed electrical contacts.
- C. Alarm check valve assembly shall be as manufactured by Tyco Fire Products or equivalent.

## **2.09 PRESSURE GAUGES**

- A. Pressure gauges shall be designed for use with water. Gauges shall be of the Bourdon type having an enclosed phosphor-bronze type. The moving parts shall be brass or stainless steel except the hairspring, which is phosphor-bronze. The case and ring shall be brass or stainless steel, and the ring shall be either threaded or pressed over the case. Gauges shall be 4-1/2 inch size with dial marking subdivisions no finer than one percent of the maximum scale reading, and shall be accurate to two percent or less. The gauge scale, when possible, shall be at least twice the maximum working pressure. All gauges shall be FM approved and UL listed.

## **2.10 TAMPER SWITCHES**

- A. All valves which control water to automatic sprinkler heads shall be equipped with supervisory switches having one normally open contact and one normally closed contact. Valve supervisory switches shall be single pole double throw switching contacts, and shall be housed in a gasketed weathertight enclosure. The supervisory device supplied shall be specifically designed to mount on, and operate reliably with, the type of control valve being monitored. All valve position switches shall be adjusted to transmit a supervisory signal within two revolutions of the valve operating hand wheel or crank (away from its full open position).

## **2.11 FLOW SWITCHES**

- A. Water flow switches shall be field adjustable vane-type with pneumatic retard and 175 psi working pressure. Units shall be single pole double throw, normally open, suitable for 24-volt, DC service or as otherwise required to interface with Building Fire Alarm system. Water flow switches shall be adjusted so that the device will transmit a water flow alarm within 90 seconds of opening the inspector's test valve on the sprinkler system. The flow switch shall be furnished and installed under this Section of Specifications and electrically connected under Division 26. Flow switches when required for zoning shall be piped and installed so that only one flow switch actuates when an alarm in that zone is present.

## **2.12 SPRINKLER HEADS**

- A. Sprinkler heads and accessories shall be UL listed or FM approved for the intended service, quick response automatic closed type, 165 deg F rated with 1/2" orifice, except as may be otherwise required for the specific application, and subject to NFPA 13 and 101 requirements and recommendations. Sprinkler heads with higher temperature ratings shall be installed in electrical and mechanical equipment areas, in areas where occupancy may generate high ambient temperatures, where installed in the vicinity of heat producing equipment, attic spaces, where exposed to the direct rays of the sun and beneath skylights and windows, and at other such locations as required by NFPA 13.
- B. Sprinkler heads installed in unfinished areas without suspended ceilings shall be upright bronze or brass. Sidewall type heads may be used in areas with low headroom as approved by the Fire Marshal.
- C. Sprinkler heads in areas with suspended ceilings including toilet facilities, storage rooms, and similar building spaces shall be chrome plated bronze pendant type. Sidewall heads in finished areas shall be horizontal, chrome plated bronze.
- D. For all building areas, except as indicated above, furnish concealed sprinkler heads consisting of sprinkler head installed within brass enclosure assembly with cover plate with white finish as approved by the Architect.
- E. Supply spare heads of each type as required by NFPA 13. Provide a metal cabinet with a sprinkler head wrench for each type head.
- F. Provide sprinkler head guards where required by NFPA 13 and where appropriate.
- G. Approved Manufacturers: Tyco Fire Products, Viking, or equivalent.

## **2.13 SYSTEM ACCESSORIES**

- A. Fire Department Connections: Fire department connections shall be of the type and style shown on the plumbing drawings, cast brass body, double clappers, plugs, and attached chains. All exposed surfaces, caps and chains shall be chrome plated. Identification shall be by raised letters on the individual devices, or shall consist of attached escutcheon plates of the same material. Label shall read "AUTO SPKR". The dimension from grade level to the center of the 2-1/2-inch inlets shall be 34 inches (plus or minus 2 inches). Make the fire department connection above the inlet to the alarm valve.
- B. Plaques: Main riser plaques shall be 7 inches by 10 inches with four mounting holes (one in each corner), and shall have white lettering on red porcelain with white blank for the "design data." Plaque shall meet all requirements of NFPA 13, Chapter 7.
- C. Strainers: Strainers, where required, shall be "Y" type with cast iron body, 30 mesh monel screen, flanged ends, 1-1/2-inch blow down connection discharging to outside, and shall be rated at 175 psi working pressure for cold water service.
- D. Splash Blocks: Splash blocks shall be concrete, 12 inches by 24 inches by 4 inches thick. A commercially available splash block may be provided as a suitable alternate.

## **2.14 ACCESS DOORS**

- A. All concealed valves, controls, etc., shall be provided with access doors as specified under Section 21 0500, Common Work Requirements.

## **PART 3 EXECUTION**

### **3.01 FIELD CONDITIONS**

- A. Prior to installation the Contractor shall carefully inspect the installed work of all other trades and verify that all such work is complete to the point where the installation of the sprinkler system may properly commence.
- B. The Contractor shall verify that the entire sprinkler system may be installed in accordance with all referenced codes, regulations, standards, and the original approved design.

### **3.02 INSTALLATION**

- A. General
  - 1. The complete fire protection system shall be installed in accordance with NFPA 13. The project drawings provide general information concerning the system arrangements, equipment, material, sizes, and other requirements and shall be utilized by the Contractor for this purpose. However, the Contractor shall have complete responsibility for the system design and installation in accordance with the requirements of this Specification.
  - 2. All pipe, fittings, valves, equipment, and accessories shall be visually examined to ensure that they are clean and free of all burrs, cracks, and other imperfections before being installed. During the progress of construction, open ends of pipes, fittings, and valves shall be properly protected at all times to prevent admission of foreign matter.
- B. Piping
  - 1. Installation of fire sprinkler piping system shall be in accordance with all applicable requirements contained in Section 21 05 00 – Common Work Requirements, Section 21 05 04 – Pipe and Pipe Fittings, and Section 21 05 05 – Piping Specialties.
  - 2. All fire sprinkler piping shall be so arranged and include such devices to separate the system into individual and distinct alarm zones as shown on the contract drawings and as required by NFPA recommendation and the Fire Marshal. A minimum of one zone per floor will be required unless shown otherwise on the contract drawings.
  - 3. Sprinkler piping shall be marked and identified in accordance with Section 21 05 00, Common Work Requirements.
  - 4. The arrangements of all piping systems shall conform to Architectural requirements and field conditions, and shall be run straight and direct, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced. Offsets will be provided where required. Standard fittings shall be used for offsets. All risers shall be erected plumb and true, and shall be parallel with the walls and other pipes and shall be neatly spaced. All work shall be coordinated with all Sections of Division 21, 22, and 23, and Division 26, "Electrical," in order to avoid interference of pipe and unnecessary cutting of floors and walls.
  - 5. No pipes or other apparatus shall be installed so as to interfere in any way with the full swing of the building doors, access doors, equipment access, etc.
  - 6. Inspector's test and test pipes shall be piped from the end of the most remote branch line of the automatic sprinkler system to the exterior of the building.

7. When trapped capacity is more than five gallons, provide auxiliary drains consisting of a one-inch valve, nipple, and cap. When trapped capacity is less than five gallons, auxiliary drain shall be one-inch nipple and cap or plug.
8. Provide main drain valves at system alarm valves and extend piping to discharge at exterior at a location approved by the Architect. All pipe and fittings downstream of drain valve shall be galvanized.
9. All concrete penetrations shall be sleeved, then grouted and sealed with fire-resistive material that shall be securely held in place.

C. Welding

1. No field welding of sprinkler piping shall be permitted.
2. Headers, risers, feed, crossmains, and branch lines may be shop welded using approved welding fittings. Welding and brazing shall conform to American National Standard Institute for Power Piping, ANSI B 31.10, with Addenda ANSI B 31.10a and ANSI B 31.10b. Welding and torch cutting shall not be permitted as a means of installing or repairing sprinkler systems.
3. Provide a blind flange at each end of welded headers.
4. Welders and brazers shall be certified for welding and/or brazing in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators. Welders must be certified for work they perform, and certificates shall be checked before the work commences.

D. Alarm Check Valve: Alarm check valves shall be installed with the valve and trim set plumb, and shall be unobstructed. Clear distances shall be as listed below:

Rear:	12 inches
Sides:	18 inches
Front:	24 inches

E. Control Valves: OS&Y fire protection control valves shall be installed so that the stem can be readily seen.

F. Sprinklers and Accessories

1. Sprinkler heads in finished areas are to be installed on a true axis line in both directions with a maximum deviation from the axis line of 1/2" plus or minus. Heads exceeding this shall be removed and reinstalled. Sprinkler heads shall be located in the center of the ceiling tiles, unless otherwise directed.
2. Provide chrome-plated escutcheons where exposed piping passes through finished floors, walls, partitions, and ceilings. Secure plates to pipe with setscrews or spring clips.
3. Provide spare sprinkler head cabinets per NFPA 13.

**3.03 EQUIPMENT INSTALLATION**

- A. Installation of all devices or equipment not specifically covered by these Specifications shall be in accordance with manufacturer's instructions.

**3.04 TEMPORARY FIRE PROTECTION**

- A. During the construction of the building and until the permanent fire extinguishing system has been installed and is in service, temporary fire protection shall be provided as required by the Fire Marshal.



### **3.05 INSPECTION AND TESTING**

- A. The complete fire protection systems and piping acceptance testing shall be performed by the Contractor and witnessed. Advance notice shall be given by the Contractor prior to any tests.
- B. Inspection Prior to Testing: The Contractor shall submit notification upon completion of the installation of all materials and equipment.
- C. Water Piping Disinfection: The Contractor shall furnish all hoses, connections, and equipment to flush piping clear and free of debris and to rinse piping of disinfectant. Flushing per NFPA Figure A-10.10-2.1. All fittings and connections required for water piping, flushing, and disinfection shall be furnished by the Contractor.
- D. Chlorine Application: Water from the existing distribution system, or other approved supply source, shall be made to flow at a constant measured rate into the newly installed piping. The water shall receive a minimum chlorine dosage of 300 mg/l. The Contractor shall not allow any anti-freeze glycerine to come in contact with the chlorine. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of chlorinated water that will expose all interior surfaces to a concentration of at least 30 mg/l for at least three hours. The application shall be checked at a tap near the downstream end of the line by chlorine residual measure. The chlorine residual measurement test shall be performed by the Contractor and the results submitted.
- E. Final Flushing: After the applicable retention period, the heavily chlorinated water in the entire system shall be flushed until the chlorine concentration is not higher than that of the source.
- F. Pressure Testing: Pressure tests shall consist of at least flushing, hydrostatic testing, and operation testing and shall be performed in strict accordance with the requirements of NFPA 13. For all above-grade piping, test pressure of 200 psi shall be held for a continuous period of two hours with no drop in pressure. Each complete system (main riser with all associated piping and alarms) shall be tested and accepted as a complete unit. System pressure test shall be against a blank test flange and not against a valve seat. Tests may be conducted by the Contractor on small sections of each complete unit for the benefit of the Contractor. An air pressure test may be provided in accordance with NFPA 13. An air pressure of 40 psig shall be pumped up, allowed to stand 24 hours, and all leaks which allow a loss of pressure over 1.5 psig during the 24 hours shall be fixed.
- G. Unsatisfactory Tests: If any of the above tests fail to produce satisfactory results, tests shall be repeated at no additional cost to the Owner until satisfactory results have been obtained.

### **3.06 CERTIFICATION**

- A. The Contractor shall certify that the system has been installed in accordance with all referenced codes and standards. The Contractor shall submit this certification upon completion of tests.

### **3.07 MAINTENANCE AND OPERATING INSTRUCTIONS**

- A. System description, system theory of operation, and system final inspection and acceptance documents of the completed system shall be submitted in a bound book (four copies). The maintenance manuals and instructions shall include a brief description of the type of system installed, routine-type work defined by step-by-step instructions that should be performed to ensure long life and proper operations, and the recommended frequency of performance. The instructions shall also include

possible trouble spots with diagnosis and suggested correction of each. The theory of operation brochures shall describe the function of each component or subassembly. A copy of the completed Contractor's Materials and Test Certificate (reference NFPA-13, Chapter 24) shall be included to document the final inspection, operating test, acceptance and placement of system in service.

**END OF SECTION**

**SECTION 22 05 00**  
**COMMON WORK REQUIREMENTS FOR PLUMBING**

**PART 1 GENERAL**

**1.01 SCOPE OF WORK**

A. See Division 23, Section 23 05 00, for applicable requirements.

**PART 2 PRODUCTS**

See Division 23, Section 23 05 00, for applicable requirements.

**PART 3 EXECUTION**

See Division 23, Section 23 05 00, for applicable requirements.

**END OF SECTION**



**SECTION 22 05 01**  
**DEMOLITION FOR PLUMBING**

**PART 1 GENERAL**

**1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

**1.02 RELATED SECTIONS**

- A. Section 22 05 00, Common Work for Plumbing.
- B. Division 1 for Cutting and Patching.

**1.03 SCOPE OF WORK**

- A. The terms "demolish" and "remove" shall mean disconnect, cart away, and dispose of off site. Components to be demolished or removed include all materials, equipment, building construction and other components as indicated. Components to be demolished shall become the property of the contractor, and contractor may dispose of them by either landfilling or by selling salvageable parts and recyclable materials to legitimate third parties.
- B. Except as specifically noted, asbestos abatement will be by others, and is not included in this contract. Advise Owner sufficiently in advance of demolition work so that Owner may arrange to have asbestos removed without delaying demolition or construction work.
- C. The Owner retains the first right of refusal on all components to be removed. When requested, remove components carefully and deposit components in locations as directed by the Owner.

**PART 2 PRODUCTS**

Not Applicable.

**PART 3 EXECUTION**

See Division 23, Section 23 05 01, for applicable requirements.

**END OF SECTION**



**SECTION 22 05 03**  
**TRENCHING AND BACKFILLING FOR PLUMBING**

**PART 1 GENERAL**

**1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

**1.02 SCOPE OF WORK**

- A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Division 22.
- B. The Contractor shall provide the services of a qualified underground locator to field locate and mark all existing buried utility lines, public and private, piping, conduits, etc., within the required construction area prior to the start of any trenching or excavation work.

**1.03 SAFETY REGULATIONS**

- A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplementary Conditions and Safety Requirements for this type of work.

**PART 2 PRODUCTS**

Not Applicable.

**PART 3 EXECUTION**

**3.01 TRENCHING AND BACKFILLING**

- A. General Excavation: The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated material not required or suitable for backfill shall be removed and wasted. Berming and grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Sheeting and shoring shall be done as required for the protection of the work and for the safety of personnel.
- B. Trench Excavation: Trenches shall be of adequate width for the proper laying of the pipe, and the banks shall be as nearly vertical as practicable and safe for workmen. The bottom of the trenches shall be accurately graded and bedded to provide uniform bearing and support for each section of the pipe at every point along its entire length. Bell holes and depressions for joints shall be dug after the trench bottom has been graded, and bedded in order that the pipe rests upon the prepared bottom for as nearly its full length as practicable. Care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 4 inches below the trench depths indicated on the drawings or specified. Overdepths in the rock and common excavation shall be backfilled with coarse sand, fine gravel, or otherwise suitable material. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable materials, as hereinafter specified.

- C. The Contractor shall move trucks and equipment on prescribed roads and keep the roads free from mud, dirt and spillage.
- D. If additional material is needed for fill on the project, it shall be furnished by the Contractor.
- E. Bracing and Bulkheading: In all excavation work the Contractor shall provide necessary underpinning, bracing, or bulkheading to safeguard the work, the present structures, workmen, the public, and the property, and shall assume all responsibility in connection therewith.
- F. Backfilling: The trenches shall not be backfilled until all required pressure tests are performed and until the utilities as installed conform to the requirements specified. The trenches shall be carefully backfilled with materials approved for backfilling; free from large clods of earth or stones. The entire depth of trench shall be backfilled in layers, and each layer shall be spread evenly, wetted to optimum moisture and thoroughly mixed to uniform consistency and compacted to the required maximum density obtainable as the same soil, as determined by ASTM D698.
- G. All imported fill required under this section will be furnished by the Contractor. Imported fill will be base course material approved for use by the State Highway Department.
- H. Fill material shall be free from trash, lumber or any type of debris which may be detrimental to producing the required density in the fill.
- I. The earth beneath all sidewalks and concrete slabs shall be backfilled and compacted to at least 8" below any gravel or sub-base material before the placement of gravel or other base material and shall be coordinated with requirements contained within Division 2.
- J. All piping not encased in concrete shall be bedded in sand or fine gravel, without rocks or other foreign material. Bedding material shall be placed around the pipe in accordance with manufacturer's recommendations. The bedding material shall be distributed around pipe to assure full consolidation.
- K. In grass and planted areas, the Contractor shall backfill his excavation to approximately 8" below finished grade. Contractor shall coordinate backfill requirements contained in Division 2.
- L. The Contractor shall protect from damage all existing underground utilities indicated on the Contract Drawings or field located by underground utility locator service. Any damage to such existing utilities shall be repaired by the Contractor without additional costs to the Owner.
- M. Provide density test for trench, backfill in accordance with Division 2 requirements.

**END OF SECTION**



**SECTION 22 05 04**  
**PIPE AND PIPE FITTINGS FOR PLUMBING**

**PART 1 GENERAL**

**1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.
- B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.
  - 1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
  - 2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

**1.02 RELATED SECTIONS**

- A. Section 22 05 00, Common Work Requirements for Plumbing.

**1.03 SUBMITTAL DATA**

- A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

**PART 2 PRODUCTS**

See Division 23, Section 23 05 04 – Pipe and Pipe Fittings, for applicable requirements.

**PART 3 EXECUTION**

See Division 23, Section 23 05 04 – Pipe and Pipe Fittings, for applicable requirements.

**END OF SECTION**



**SECTION 22 05 05**  
**PIPING SPECIALTIES FOR PLUMBING**

**PART 1 GENERAL**

**1.01 REQUIREMENTS**

- A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.
- B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.
  - 1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
  - 2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

**1.02 RELATED SECTIONS**

- A. Section 22 05 00, Common Work Requirements for Plumbing.
- B. Section 22 05 04, Pipe and Pipe Fittings for Plumbing.
- C. Section 22 05 23, Valves for Plumbing.
- D. Section 22 07 00, Plumbing Insulation.
- E. Section 22 05 49, Plumbing and Electrical Installation Coordination.

**1.03 SUBMITTAL DATA**

- A. The Contractor shall furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approvals of listing agencies, wiring diagrams, and selection analysis.

**PART 2 PRODUCTS**

See Division 23, Section 23 05 05, Piping Specialties.

**PART 3 EXECUTION**

See Division 23, Section 23 05 05, Piping Specialties.

**END OF SECTION**



## **SECTION 22 05 23 VALVES FOR PLUMBING**

### **PART 1 - GENERAL**

#### **1.1 REQUIREMENTS**

- A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.
- B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.
- C. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.
  - 1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
  - 2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

#### **1.2 RELATED SECTIONS**

- A. Section 22 05 00, Common Work Requirements for Plumbing.
- B. Section 22 05 04, Pipe and Pipe Fittings for Plumbing.
- C. Division 21 for Fire Suppression System.
- D. Division 22 for Plumbing.

#### **1.3 SCOPE**

- A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

#### **1.4 VALVE REQUIREMENTS**

- A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Grinnell, or equivalent.
- B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.
- C. Ball valves shall be utilized in lieu of gate valves and globe valves for all plumbing systems for sizes 2" and smaller.
- D. All valves of the same type shall be products of a single manufacturer.
- E. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.
- F. Provide chain operators for valves 4" and larger installed within mechanical equipment spaces where valves center line is in excess of eight feet above the floor or operating platform and as otherwise indicated on the drawings.

### **PART 2 - PRODUCTS**

See Division 23, Section 23 05 23 - Valves, for applicable requirements.

### **PART 3 - EXECUTION**

See Division 23, Section 23 05 23 - Valves, for applicable requirements.

## **END OF SECTION**



**SECTION 22 05 49**  
**PLUMBING AND ELECTRICAL INSTALLATION COORDINATION**

**PART 1 GENERAL**

**1.1 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

**1.2 RELATED DIVISIONS AND SECTIONS**

- A. Section 22 05 00, Common Work Requirements for Plumbing.
- B. Section 23 09 00, Facility Management System.
- C. Division 26 for Electrical.
- D. Division 28 for Electronic Safety and Security.

**1.3 SCOPE**

- A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.
- B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.
- C. Make all connections to motors and controls for equipment supplied and/or installed under Division 22 according to Table 1 on the following page.

**PART 2 PRODUCTS**

Not Applicable.

**PART 3 EXECUTION**

**3.1 INSTALLATION**

- A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

**TABLE 1**

<b>Item or System</b>	<b>Note</b>	<b>Supplied By (3)</b>	<b>Installed By (3)</b>	<b>Powered By</b>	<b>Control Field Wiring By</b>
Equipment Motors		Div. 22	Div. 22	Div. 26	N/A
Motor Control Center Including Starters, Pilot Lights, Heater, Switches, Auxiliary Contacts, and Internal Control Wiring		Div. 26	Div. 26	Div. 26	Div.23
Stand Alone Motor Starters (outside motor control centers)	(1)	Div. 26	Div. 26	Div. 26	Div. 23
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 22	Div. 22	Div. 26	Div. 23
Boilers & Domestic Water Heaters		Div. 22	Div. 22	Div. 26	Div. 23

**TABLE NOTES:**

1. Unless specified to be supplied with the equipment
2. Division 26 shall coordinate with Division 23, FMS Contractor as required to provide 120 VAC power to each mechanical space and the central plant as necessary for the FMS and as shown on the drawings. Any additional power, transformers, and distribution shall be provided by the Section or Division indicated.
3. Division 22 indicates the plumbing contractor or their designated representative including equipment suppliers, sub-contractors, etc.

**END OF SECTION**



## **SECTION 22 07 00 PLUMBING INSULATION**

### **PART 1 GENERAL**

#### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.
- B. Materials shall conform to applicable ASTM standards.

#### **1.02 RELATED SECTIONS**

- A. Section 22 05 00, Common Work Requirements for Plumbing.
- B. Section 22 05 04, Pipe and Pipe Fittings for Plumbing.

#### **1.03 SCOPE**

- A. Domestic hot water pipe including circulating hot water], interior roof drains including roof drain bowls, interior overflow roof drains including overflow roof drain bowls, domestic cold water, water piping located outdoors exposed to ambient freezing conditions.

#### **1.04 FITTINGS**

- A. All fittings except as otherwise specified, shall be insulated with the same material and thickness as specified for the pipe.
- B. Unions, flanges and valves on hot water, will not require insulation.

#### **1.05 TESTING**

- A. All piping shall be tested in accordance with the applicable Specification Sections, before any insulation is applied.

### **PART 2 PRODUCTS**

#### **2.01 INSULATION**

- A. Insulation shall be as manufactured by Owens-Corning Fiberglas, Knauf, CertainTeed, Johns Manville, or Armstrong, or equivalent, and shall be equal to that specified below. Insulation and all materials on the interior and exterior surfaces of ducts, pipes, and equipment shall have a composite fire and smoke hazard rating not exceeding: Flame spread - 25; fuel contribution - 50; smoke developed - 50, as determined in accordance with ASTM Standard E-84. All insulation materials used for valves and fittings shall have the same ratings as the pipe insulation. Information must be submitted by means of manufacturer's literature showing that the proposed materials conform to above specification without exception.
- B. Fiberglass pipe insulation shall be rigid molded and non-combustible with 'K' factor of 0.23 at 75°F. Jacket shall be all service (ASJ) vapor barrier jacket with white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self sealing longitudinal laps and butt strips. Johns Manville 'Micro-Lok' or equivalent.
- C. Hydros Calcium Silicate insulation shall be rigid molded, non-combustible per ASTM E 136, conforming to ASTM 533, asbestos-free with 'K' factor of 0.40 at 300°F., maximum service temperature 1200°F., compression strength (block) minimum of 200 PSI to produce 5% compression at 1-1/2" thickness. Johns Manville 'Thermo-12 Gold' or equivalent.

- D. Fiberglass rigid board insulation for equipment shall conform to ASTM C612 with 'K' factor of 0.23 at 75°F, R=8.0 minimum, 3.0 pound per cubic foot density. Provide vapor barrier jacket (FSK) with aluminum foil reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and outward clinched expanded staples and vapor barrier mastic. Johns Manville 'Spin-Glas' or equivalent.
- E. Elastomeric foam insulation for piping and equipment shall be flexible, cellular, molded or sheet, conforming to ASTM C534, with 'K' factor of 0.28 at 75°F., maximum service temperature of 220°F., maximum flame spread rating of 25 and maximum smoke development rating of 50 (3/4" thickness and less). Connections shall be made using manufacturer's approved waterproof vapor barrier retarder adhesive. Provide outdoor U.V. protective coating on all insulation exposed to ambient conditions.

## **2.02 FITTINGS**

- A. Valves and fittings, where required to be insulated, shall be covered with the same insulation material and thickness as specified for the pipe insulation and finished with PVC covers.
- B. Valves and fittings with systems specified to be covered with metal or canvas, or polyvinyl chloride (PVC) jacket shall be covered with material to match piping system jacketing.
- C. Polyvinyl chloride (PVC) preformed fitting covers with fiberglass inserts shall be used on valves and fittings, except where metal or canvas jacket is required for piping system. PVC fitting covers shall be Zeston 2000 or equivalent, gloss white and shall have a composite fire and smoke hazard rating not exceeding; flame spread - 25; smoke development - 50. Connections shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

## **2.03 PVC JACKETING**

- A. PVC jacketing shall be Zeston 2000 or equivalent, gloss white, 0.020 inch thickness, minimum, and shall have a composite fire and smoke hazard rating not exceeding; flame spread -25; smoke development -50. Connection shall be made using tacks and pressure sensitive color matching vinyl tape. Seams shall be on the bottom side of pipe and fittings.

## **2.04 PIPE HANGERS AND SUPPORTS**

- A. See Specification Section 22 05 04 for requirements associated with hangers and supports for piping systems.
- B. All insulated piping systems shall be provided with individual hangers sized to encircle the insulation. Hangers for domestic cold water and roof drains may be installed under the insulation, provided that the vapor barrier system for cold piping and the hanger rods are protected from the formation of condensation by application of a heavy coating of vapor barrier mastic material.
- C. Insulated piping supported by means of trapeze hangers or roller type hangers shall not rest directly on the hanger or support.
- D. The insulation at hangers, trapezes and supports shall be protected by means of galvanized steel insulation half diameter support shields. Provide insulation insert between support shield and piping for piping size 1-1/2" and larger. Insulation inserts shall be heavy density calcium silicate molded insulation. Insulation inserts shall be the following minimum lengths. Factory fabricated thermal pipe shield as manufactured by Pipe Shields, Inc., and specified in Section 22 05 04, may be used at Contractor's option.

<u>Pipe Size, In.</u>	<u>Insert Length</u>
1-1/2" to 2-1/2"	10" Long
3" to 6"	12" Long
8" to 10"	16" Long
12" and larger	22" Long

## **2.05 PIPE SLEEVES**

- A. See Specification Section 22 05 04 for requirements associated with pipe sleeves for piping penetrations for building walls and frames.
- B. Pipe sleeves shall be provided at penetrations through concrete and masonry construction and at fire rated and smoke rated walls and penetrations when required to comply with UL approved penetration assembly. Insulated piping passing through fire walls and smoke walls shall be provided with UL approved fire safing insulation to match the required insulation thickness and the space between the piping penetration and the adjacent wall construction shall be sealed air tight with UL approved fireproof caulking material. Pipe penetration arrangement and installation requirements shall match the applicable UL approved penetration assembly details.

## **PART 3 EXECUTION**

### **3.01 DOMESTIC HOT WATER PIPING**

- A. Domestic hot water piping with operating temperatures of 140°F and less, including recirculating hot water piping shall be insulated with 1-inch thick fiberglass preformed pipe insulation with All Service Jacket (ASJ). Fittings shall be finished with PVC fitting covers.
- B. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

### **3.02 DOMESTIC COLD WATER AND ROOF DRAINS**

- A. Domestic cold water piping shall be insulated with 1-inch thick fiberglass preformed pipe insulation with All Services Jacket (ASJ). Fittings shall be finished with PVC fitting covers. Cold water piping installed within interior partitions, not less than 10 feet from an exterior wall, and where no return air is present, need not be insulated.
- B. Roof drain bowls and horizontal roof drain piping shall be insulated with 1-inch thick fiberglass insulation as specified for domestic cold water piping.
- C. Overflow roof drain bowls and horizontal overflow roof drain piping shall be insulated with 1-inch thick fiberglass insulation as specified for domestic cold water piping.
- D. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

### **3.03 HANDICAP LAVATORY AND SINKS**

- A. Domestic hot and cold water piping and P-traps exposed below handicapped lavatories and sinks shall be insulated with HANDI LAV-GUARD insulation kits which satisfy ANSI A117.1 requirements. Insulation shall have a flexible vinyl finish which protects against burning and cushions impact.
- B. Countertop sinks indicated within the Architectural drawings to be handicap-compliant shall have an off-centered drain opening and a maximum sink depth of 7-inches.

### **3.04 PVC JACKETING**

- A. PVC jacketing shall be installed on all field insulated plumbing equipment and on all piping systems exposed within the mechanical equipment spaces and where noted on the drawings and specifications, except where metal or canvas jacketing is required.
- B. Jacketing shall be secured in place in an approved manner by means of tacks and pressure sensitive tape.
- C. Fittings and valves shall have insulation covered with PVC pre-molded PVC fittings to match jacketing, as specified below.
- D. PVC jacketing shall not be permitted for use on exterior piping systems.

### **3.05 TERMINATION OF INSULATION**

- A. The termination of all insulation on pipes, at uninsulated valve connections, or unions, flexible connections, etc., shall be beveled and finished.

### **3.06 FACTORY INSULATED EQUIPMENT**

- A. Domestic water heaters and other equipment as specified in the equipment schedules on the drawings shall be factory insulated.

**END OF SECTION**

## **SECTION 22 11 00**

### **DOMESTIC WATER PIPING**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Conform with the applicable provisions of the General Conditions, Supplemental General Conditions, and the General Requirements.
- B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.
  - 1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
  - 2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead. Solder shall be 95/5 tin antimony, alloy Sb5, conforming to FS QQ-S-571 and NSF 61.

##### **1.02 RELATED SECTIONS**

- A. Section 22 05 00, Common Work Requirements for Plumbing
- B. Section 22 0 504, Pipe and Pipe Fittings for Plumbing.
- C. Section 22 05 05, Piping Specialties for Plumbing.
- D. Section 22 05 23, Valves for Plumbing.
- E. Section 22 07 00, Plumbing Insulation.
- F. Section 22 68 01, Onsite Utilities, Plumbing.

##### **1.03 SCOPE**

- A. A complete domestic cold water, hot water, recirculating hot water, and make-up water system including water heaters, pumps, thermal expansion tanks, backflow protection, shock absorbers, and associated miscellaneous accessories. This section shall include all work within the building to a point approximately 5'-0" outside the building, or as otherwise indicated.

#### **PART 2 PRODUCTS**

##### **2.01 PIPING**

- A. Domestic water piping below grade or slab-on-grade shall be Type L soft copper, ASTM B88. Copper piping 2" and smaller shall be soft tubing and 2-1/2" thru 4" shall be either soft tubing or hard pipe. Domestic water piping 6" and larger below grade within the building and to a point approximately 5'-0" from the building shall be ductile iron pressure pipe, minimum 150 PSIG working pressure with mechanical joints. Wrap all underground copper pipe and fittings with minimum 20 mil polyethylene with minimum 50% overlay, provide for taping.
- B. Domestic water piping above grade within the building 4" and smaller shall be Type L hard drawn copper, ASTM B88. Domestic water piping larger than 4" shall be copper as specified herein.
- C. Proper insulating fittings, as specified in Section 22 0504, shall be installed to prevent electrolytic action between steel and copper piping connections.

## **2.02 FITTINGS**

- A. Fittings for copper piping shall be wrought copper or cast brass conforming to ANSI B16.22 and B16.23, with 95-5 solder joints, as specified in Section 22 05 04.
- B. Mechanically formed tee connections and couplings for copper piping system as specified in Section 22 05 04, may be utilized where approved.

## **2.03 FLANGES**

- A. Flanges for copper piping systems shall be Class 150 wrought copper or cast brass conforming to ANSI B16.24.
- B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.
- C. Flanges for galvanized steel piping system shall be galvanized cast or malleable iron Class 125, standard threaded plain face companion flanges for flanged connections in threaded piping systems.
- D. Gaskets shall be 1/16" thick ring type or full face non-asbestos material suitable for the temperatures and pressure application.
- E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

## **2.04 JOINTS**

- A. Joints in copper piping system shall be made using approved "lead-free" solder and flux as described herein and approved by all applicable codes and regulations. Surfaces to be soldered shall be cleaned bright by manual or mechanical means.
- B. All joints shall be properly fluxed with a non-corrosive "lead-free" type flux manufactured to approved standards, Federal Specification QQ-S-517. Joints for copper piping systems for cold water 3" and smaller and hot water 2" and smaller shall be made using composition 95-5 tin-antimony solder. Composition 15% silver solder shall be used for all other piping sizes and for all underground joints.

## **2.05 SHOCK ABSORBERS**

- A. Furnish and install factory sealed shock absorbers conforming to Federal Specification WW-P-541 at locations shown on the drawings and/or as outlined by Plumbing Drainage Institute Standard WH-201. Josam, Precision, Jay R. Smith, Wade, Watts, Zurn or equivalent.

## **2.06 DOMESTIC HOT WATER GENERATING EQUIPMENT**

Water heaters and associated auxiliary equipment shall be as specified on the equipment schedule on the drawings. Natural gas fired or electric domestic water heaters shall be as manufactured by Bock, Bradford-White, Lochinvar, P.V.I., Ruud, Rheem, A.O. Smith, State, or equivalent.

- A. Furnish and install approved expansion tank on cold water make-up supply to hot water generating equipment as recommended by manufacturer or as shown on the drawings and specified in the plumbing equipment and fixture schedule on the drawings, Amtrol, Wilkins, or approved equal.
- B. Natural gas fired domestic hot water boilers and water heater combustion flues, stack, breeching, and combustion air louvers, ducts, etc., shall be provided under Division 23.

## **2.07 VALVES**

- A. Valves other than automatic control valves are specified in Section 22 05 23, Valves.

- B. Automatic control valves shall be as specified in Section 23 09 00, Facility Management System, except for automatic control valves furnished as a part of equipment packages, including hot water generating equipment, as specified on the equipment schedule.

## **2.08 PUMPS**

- A. Pumps shall be of the type and capacity listed in the equipment schedule. Pumps shall be selected so that the motors will not overload under any operating condition. Furnish one spare mechanical seal of each size required in conjunction with the pumps furnished under this Contract. All base mounted pumps shall have drain pans with tapped pipe connections and 3/4" drain line extended to floor drain. Pumps shall be installed so that they may be removed without the removal of the associated piping. All pumps for potable water applications shall have bronze or stainless steel body and trim.
- B. Domestic water inline re-circulating pumps shall be as specified on the drawings and as manufactured by Armstrong, Bell & Gossett, Taco, Thrush, or equivalent.

## **2.09 WATER METER**

- A. Domestic water meter assembly shall be furnished by the City of Colorado Springs. Meter size and general arrangement shall be as indicated on the drawings. The Contractor shall coordinate with the applicable representatives for the installation of the water meters and shall furnish all associated piping, valves and materials, including meter box/vault, in accordance with details on the drawings and applicable Requirements.
- B. All costs, fees, and permits required for the installation of the water meter shall be secured and paid for by the Contractor unless otherwise indicated.
- C. Water meters shall be installed by the Contractor in accordance with the information shown on the drawings and in the Plumbing Fixture Schedule on the drawings.

## **2.10 BACKFLOW PROTECTION**

- A. All cross-contamination control shall be provided to ensure that no installation of the potable water supply piping system shall be made in a manner that will allow used, unclean, polluted, or contaminated water or substances to enter the domestic potable water system.
- B. All backflow devices and assemblies shall be approved by the applicable Administration Authorities and shall be installed according to all applicable codes, regulations, and manufacturer's instructions. Installation shall allow for required access and clearance for required testing, maintenance, and repair.
- C. Reduced pressure backflow preventer assembly shall be furnished and installed by the Contractor. Backflow preventer size and arrangement shall be as indicated on the drawings, and shall be as manufactured by Febco, Hersey, Beeco, Watts, Wilkins, or equivalent. All costs, fees, and permits required shall be secured and paid for by the Contractor, unless otherwise indicated.
- D. See Section 23 0504 for backflow preventer required for make-up water connections to HVAC systems.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Piping installation shall conform to the requirements of Section 22 05 00, Common Work Requirements for Plumbing and Section 22 05 04, Pipe and Pipe Fittings for

Plumbing. Installation of specialties shall conform to the requirements of Section 22 05 05, Piping Specialties for plumbing.

- B. Insulating Fittings: Insulating unions shall be furnished and installed at all connections between dissimilar metals.
- C. Valves: Each water service main, branch main and branch to a group of two or more fixtures shall be valved. Stop valves shall be as specified under fixtures.
- D. Flexible Connections: If the Contractor uses a pipe material other than copper to connect to the City water main, provide mechanical joints at the connection point and also either a swing joint or expansion joint at a point 5 ft. outside the building to prevent failure of piping caused by differential settling of building and piping systems. The expansion joint material shall be suitable for domestic water usage and compatible with the sterilization chemicals.

### **3.02 STERILIZATION**

- A. All new water piping shall be charged with a chlorine solution containing not less than 50 PPM available chlorine. The solution shall remain in the piping for a period of 24 hours, during which time valves shall be opened and closed to permit a small flow of the solution. At the end of 24 hours, the solution shall be tested and must contain a residual of at least 5-10 PPM chlorine. The system shall then be drained and flushed to provide satisfactory potable water before final connection is made to the existing distribution system.
- B. The Contractor shall submit a sample of the water, after sterilization and flushing for testing by an approved laboratory. A copy of the acceptable test report shall be submitted to the Architect prior to substantial completion.

### **3.03 BACKFLOW PROTECTION**

- A. Protection: All plumbing fixtures, faucets with hose connections, and all other equipment having plumbing connections shall have their water supplies protected against back-siphonage.
- B. Testing: Arrange for testing backflow devices as required by the local health authorities.

### **3.04 TESTS**

- A. All water piping, hot and cold, shall be made tight under a hydrostatic test pressure of 150 lbs. per square inch and maintained without pressure loss for a minimum of four (4) hours. No caulking of joints will be permitted. Any joint found to leak under this test shall be broken, remade and a new test applied.

## **END OF SECTION**



## **SECTION 22 11 23**

### **FACILITY NATURAL GAS SYSTEM**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions and Supplemental General Conditions.

##### **1.02 RELATED SECTIONS**

- A. Section 22 05 00, Common Work Requirements for Plumbing.
- B. Section 22 05 04, Pipe and Pipe Fittings for Plumbing.
- C. Section 22 05 05, Piping Specialties for Plumbing.
- D. Section 22 05 23, Valves for Plumbing.

##### **1.03 SCOPE**

- A. Complete building natural gas piping system including meters, regulators, and miscellaneous accessories. This section shall include all work within the building and to a point approximately 5'-0" outside the building, or as otherwise indicated.

#### **PART 2 PRODUCTS**

##### **2.01 PIPING**

- A. Above ground pipe used for the installation, extension, alteration, and/or repair of any gas piping system shall be black steel pipe ASTM A53 Grade A or B, ERW or BW, standard wall, Schedule 40.

##### **2.02 FITTINGS**

- A. Fittings for steel piping 2" and smaller shall be either screwed or welded. Screwed fittings shall be Class 150 standard black malleable iron conforming to ANSI B16.3. Weld fittings shall be either standard weight steel butt-weld fittings conforming to ANSI B16.9, or forged steel socket-weld fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.
- B. Fittings for steel piping 2-1/2" and larger shall be standard weight steel butt-weld fittings conforming to ANSI B16.9.

##### **2.03 FLANGES**

- A. Flanges for steel piping system shall be forged steel, weld neck, or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5.
- B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.
- C. Where specifically required by the application, black cast iron Class 125 standard threaded plain face companion flanges may be utilized for flanged connections in threaded piping systems.
- D. Gaskets shall be 1/16" thick full face non-asbestos material suitable for the temperatures and pressure application.
- E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

##### **2.04 VALVES**

- A. Valves shall be as specified in Section 22 05 23, Valves for Plumbing.
- B. Valves used in conjunction with gas piping shall be approved for the required service.

## **2.05 NATURAL GAS REGULATOR**

- A. Natural gas regulator shall be furnished and installed with the gas meter by the utility company, set for the required gas leaving pressure shown on the drawings.
- B. Natural gas appliance and equipment regulators for all gas fired equipment furnished and installed under Division 23 shall be furnished by the equipment manufacturer or supplier and sized for the system inlet pressure and the required appliance operating pressure.
- C. Natural gas regulators, as specified and shown on the drawings, shall be furnished and installed by the Contractor.

## **2.06 PIPING SUPPORTS**

- A. Natural gas piping installed on the building roof shall be supported by means of piping supports, especially designed to absorb thermal expansion and contraction of piping installed on built up and single ply membrane roofs. Wood blocks are not acceptable. Four inch and smaller gas piping shall be mounted on Erico Pyramid pipe supports or equivalent, pipe supports with a total weight not to exceed 100 pounds per pipe stand. Larger piping, and all piping requiring roller bearing action for pipe expansion, shall be mounted on Erico Pyramid RPS-H or equivalent, with a total weight not to exceed 1500 pounds per pipe collar support. Pipe support spacing shall be as recommended by manufacturer and as required by Code.
- B. Piping hangers and supports shall be in accordance with Section 22 05 04, Pipe and Pipe Fittings for Plumbing.

## **2.07 PAINTING**

- A. All natural gas piping installed outside the building exposed to the weather and/or exposed to view shall be field painted in accordance with the painting sections of this specification.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Piping installation shall conform to the requirements of Section 22 05 00, Common Work Requirements for Plumbing, and Section 22 05 04, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 05 05, Piping Specialties for Plumbing.
- B. Installation of piping and equipment shall be in accordance with applicable codes and regulations, including International Fuel Gas Code and International Mechanical Code, and NFPA No. 54, National Fuel Gas code.
- C. No gas piping shall be installed in or on the ground under any building or structure, and all exposed gas piping shall be at least 6-inches above grade. Ferrous gas piping installed underground in exterior locations shall be protected for corrosion as specified herein and in Section 22 05 04, Pipe and Pipe Fittings for Plumbing.
- D. Gas piping supplying the building or facility shall be provided with a shut-off valve located outside the building and readily accessible. Where gas piping supplies multiple buildings or facilities, each building shall be provided with a shut-off valve as described herein.

### **3.02 EQUIPMENT AND APPLIANCE CONNECTIONS**

- A. All gas fired equipment and appliances shall be connected to the gas piping system in an approved manner and shall be furnished with a shut-off valve installed ahead of the unit. Connections shall in no case be less than the unit inlet connection size and

shall be rigidly connected, except as otherwise shown on the drawings and allowed by codes and regulations.

**3.03 DRIPS**

- A. Accessible capped drip pockets shall be furnished at low points in piping system, connections to appliances and equipment, and other locations where condensation may tend to collect.

**3.04 VENTS**

- A. All gas regulators and other required devices installed within the building shall be vented to the outside of the building in accordance with manufacturer's requirements, codes, and regulations.

**3.05 TESTS**

- A. All gas piping shall be pressure tested using air, CO<sub>2</sub>, or nitrogen in accordance with the applicable codes and regulations, including International Fuel Gas Code as adopted and interpreted by the State of Colorado and NFPA No. 54.

**END OF SECTION**



## **SECTION 22 13 16**

### **SANITARY WASTE AND VENT PIPING**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions and Special Provisions.
- B. Furnish and install all concrete, grout, and other required materials to fill all blockouts and/or sleeves left open for this Contractor's convenience or for the installation of this work.

##### **1.02 RELATED SECTIONS**

- A. Section 22 05 00, Common Work Requirements for Plumbing.
- B. Section 22 05 04, Pipe and Pipe Fittings for Plumbing.

##### **1.03 SCOPE**

- A. Complete soil, waste, and vent system, and associated miscellaneous accessories. This section shall include all work within the building to a point approximately 5'-0" outside the building, or as otherwise indicated.
- B. Plumbing equipment drains.

#### **PART 2 PRODUCTS**

##### **2.01 PIPING**

- A. Soil, waste, and vent piping below slab on grade shall be service weight cast iron no hub or bell and plain end pipe, coated inside and outside, conforming to ASTM A-74 and 87 Standards.
- B. Soil, waste, and vent piping above grade shall be either service weight cast iron no hub or bell and plain end pipe, coated inside and outside, conforming to ASTM A-74 and 87 standards. At the Contractor's option or if specifically noted on the drawings, copper DWV pipe may be used.
- C. No-hub cast iron pipe shall conform to CISPI Standard 301 and shall be marked with CISPI Label.
- D. All above and/or below ground cast iron pipe and/or fittings shall be marked with the trademark of the Cast Iron Soil Pipe Institute.

##### **2.02 FITTINGS**

- A. Fittings for cast iron sanitary soil, waste and vent piping system shall be service weight or no-hub cast iron drainage pattern conforming to ASTM C564. Fittings shall be provided to match the required piping system.
- B. No-Hub pipe fittings shall comply with CISPI Standard 301 and shall be marked with CISPI Label.
- C. Fittings for copper piping system shall be solder type drainage pattern conforming to ANSI B16.22 and B16.23.

### **2.03 JOINTS**

- A. Joints for cast iron pipe and fittings shall be suitable to match the required piping system and shall be either lead and oakum, double seal compression-type molded neoprene gaskets conforming to ASTM C-564 Standards, and suitable for the class of pipe being jointed, with adhesive type joint lubricant, Tyler "LUBRI/FAST" or equivalent. No-hub coupling shall be minimum four (4) band type with neoprene gasket material conforming to ASTM C-564, and 0.008-inch minimum, Type 304 stainless steel shear ring. Couplings shall be Tyler "Wide Body", Huskey Series 4000, Clamp-All, Mission Heavy Weight, Ideal, or equivalent.
- B. Joints for galvanized steel shall be threaded, made with approved joint compound.
- C. Joints for copper shall be soldered using 95-5 composition tin-antimony solder with non-corrosive flux.

### **2.04 PLUMBING EQUIPMENT DRAINS**

- A. Equipment drain lines shall be either Schedule 40 galvanized steel pipe with galvanized malleable iron fittings or Type L copper tubing with wrought solder fittings. Provide a dielectric union at all connections between ferrous to copper materials.

### **2.05 DRAINS**

- A. Floor drains, floor sinks, and interceptors shall be Josam, Rockford, Jay R. Smith, Wade, Watts, Zurn, Mifab, or equivalent, as specified on the drawings, and compatible with the required piping systems.

### **2.06 TRAPS AND TAILPIECES**

- A. Unless otherwise specified, traps shall be copper-alloy adjustable tube type with slip joint inlet and swivel, not less than 20 gauge and without cleanout. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level and swivel joints below the discharge level, metal to metal or metal to plastic type as required for the application. Outlet shall be threaded or socket for solder joint connection as required by the application. Tailpiece shall be copper-alloy to match P-trap. Furnish cast brass wall escutcheon at waste penetration through walls. P-traps, tailpieces, escutcheon, and all piping for above floor exposed installations, including installation within cabinets and casework shall be chrome plated. Underground P-traps shall be coated cast iron as required by the application.
- B. Traps and associated trim shall be furnished by the plumbing fixture manufacturer as specified in Section 22 40 00 and in the Fixture Schedule on the drawings, or shall be as manufactured by Dearborn, EBC, McGuire, T & S Brass, or equivalent.

### **2.07 CLEANOUTS**

- A. Cleanouts shall be as manufactured by Zurn, Jay R. Smith, Watts, Wade, or Josam, and shall be of the same size as the pipe, except that cleanout plugs larger than 4 inches will not be required. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep, quarter-bend or one or two eighth bends extended to an easily accessible place, or as indicated on the drawings. A standard cleanout fitting, Zurn No. ZN-1400-ZB, with polished bronze top shall be caulked into the hub of the fitting and finished flush with the floor. Heavy duty cleanouts shall be Zurn Z-1474, with integral anchor flanges. Where cleanouts in connection with threaded pipe are shown and are accessible, they shall be cast iron drainage T-pattern, 90 degree branch fittings with square head brass screw plugs of the same size as the pipe up to and including 4 inches. Wall cleanouts in finished areas shall be Zurn No. Z-1460-8 with polished stainless steel or chrome plated metal cover.

- B. Cleanouts for acid resistant piping system shall be compatible material for the required piping system.
- C. Install cover flush with grade (outside) to avoid tripping hazard.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Piping installation shall conform to the requirements of Section 22 05 00, Common Work Requirements for plumbing, and Section 22 05 04, Pipe and Pipe Fittings for Plumbing. Installation of specialties shall conform to the requirements of Section 22 05 05, Piping Specialties.
- B. All soil, waste, and vent piping shall be properly graded and installed in strict accordance with all applicable codes and requirements.
- C. Make all changes in direction of drainage piping by use of 45 degree wyes, long turn tee wyes, long sweep quarter bends, sixth, eighth or sixteenth bends. Short turn sanitary tees permissible on horizontal to vertical where space conditions require.

#### **3.02 FLASHINGS**

- A. Flashing for piping through built-up roofing with lead flashing, weight of not less than four pounds per square foot, extending at least 12" in all directions under roofing and up pipe. Cap flash pipe and turn down inside 1" approximately. Run all pipes extending through roof prior to roof installation. Flashing shall be two-piece type, base and cap flashing.

#### **3.03 DRAINS**

- A. All floor drains, area drains, and floor sinks shall be installed with grates square with building lines and with the top of grates installed level with adjacent finished floor.
- B. The Contractor shall extend drain lines from all equipment requiring drainage, relief valves, and drain pans to the nearest floor drain or floor sink, and shall terminate indirectly with a minimum clearance of one (1) inch or as otherwise required by applicable codes and standards. Relief valve drain lines shall be extended to the nearest floor drain and shall be equal in size to relief valve outlet port.

#### **3.04 TESTS**

- A. The sanitary soil waste and vent system and condensate drain system shall be tested by filling system with water. System shall remain filled with no loss of water for a minimum of 2 hours. The system water test shall be applied to the drainage and vent systems either in its entirety or in sections. Preliminary testing shall be accomplished as necessary prior to final test.
- B. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than ten (10) feet of water. In testing successive sections, at least the upper ten (10) feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet) of the system shall have been submitted to a test of less than a ten (10) foot head of water. The system shall then be tight at all points.

### **END OF SECTION**





## **SECTION 22 40 00**

### **PLUMBING FIXTURES AND TRIM**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.
- B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.
  - 1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
  - 2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

##### **1.02 RELATED SECTIONS**

- A. Section 22 05 00, Common Work Requirements for Plumbing.
- B. Section 22 05 04, Pipe and Pipe Fittings for Plumbing.
- C. Section 22 11 00, Domestic Water Piping.
- D. Section 22 13 16, Sanitary Waste and Vent Piping.

#### **PART 2 PRODUCTS**

##### **2.01 FIXTURES AND EQUIPMENT**

- A. Vitreous china and enameled cast iron fixtures by American Standard, Kohler, Sloan, Zurn, Mansfield, Toto, or equivalent as listed and described in the plumbing fixture schedule on the drawings. All vitreous china and enameled cast iron fixtures shall be white, unless otherwise indicated on the drawings. The material used for plumbing fixtures shall be of non-absorptive, acid-resistant vitreous china, enameled cast iron or stainless steel, and free from all imperfections. Each water service main, branch main, riser and branch to a group of fixtures shall be valved or as otherwise shown on the drawings to provide more stringent requirements. Stop valves shall be provided at each fixture. One piece chrome plated escutcheons shall be installed on all water piping and trap connections at walls or base cabinets. All exposed connecting piping and material shall be chrome plated.
- B. Handicap accessible lavatories and counter mounted sinks shall have exposed supply and waste services insulated with rigid, molded insulation kits as manufactured by T.C.I. "Skal-Gard", Brocar "Trap Wrap", True-Bro "Handi Lav-Guard", McGuire "Prowrap", or equivalent. Provide off-set tail piece fittings on all handicap accessible laboratories and sinks as required.
- C. Flush valves shall be low water consumption type as specified on drawings. Valves shall be diaphragm or piston type, with metal oscillating non-hold open handle, screw driver back check angle stop assembly with cap, adjustable tailpiece, vacuum breaker flush connection, and spud couplings as required for wall and fixture rough-in. Exposed flush valves shall be fully chrome plated, with chrome plated supply pipe cover. Flush valves shall be Delany, Sloan Royal, Sloan Regal, Zurn, American Standard, Toto, or equivalent.
- D. Closet seats shall be furnished for water closets as specified on the Plumbing Fixture Schedule on the drawings. Closet seats shall be white unless otherwise required to match water closet. All closet seats shall be of smooth non-absorbent material and shall be properly sized for the water closet bowl type. All closet seats for fixtures for public use shall be open-front type without cover. Water closet seats provided for handicapped

fixtures shall meet all handicapped requirements. Hinges, posts, nuts, and pintles shall be of a 300 series stainless steel construction. Water closet seats shall be furnished by the plumbing fixture manufacturer as specified on the Fixture Schedule on the drawings, or shall be as manufactured by Bemis, Beneke, Centoco, Church, Olsonite, Sperzel, or equivalent.

- E. Floor mounted mop sinks shall be as specified on the Plumbing Fixture Schedule on the drawings, molded stone or terrazzo, size and arrangement as shown on the drawings, as manufactured by Acorn, Centoco, Designer's Choice, Fiat, Mustee, Stern-Williams, Zurn, or equivalent.
- F. Stainless steel sinks shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Kohler, American Standard, Elkay, Just, Advance Tabco, Moen, Intersan, or equivalent. Countertop sinks indicated within the Architectural drawings to be handicap-compliant shall have an off-centered drain opening and a maximum sink depth of 7-inches. All sink basins shall have a center-rear outlet unless noted otherwise.
- G. Electric water coolers (EWC) and drinking fountains shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Elkay, Guardian, Haws, Halsey Taylor, Oasis, Sunroc, Acorn Aqua, or equivalent.
- H. Hose bibbs and wall hydrants shall be as specified on the Plumbing Fixture Schedule on the drawings and as manufactured by Zurn, Jay R. Smith, Wade, Woodford, Acorn, Chicago, T&S Brass, Watts, Prier, or equivalent. Handles, if specified shall be constructed of metal or brass and finished to match valve unit.
- I. Shower valves and mixing valves shall be as specified on the Plumbing Fixture Schedule on the drawings, and as manufactured by Powers, Leonard, Lawler, Speakman, Symmons, Bradley, or equivalent.
- J. Emergency fixtures including showers and eyewash shall be as specified on the Plumbing Fixture Schedule on the drawing and as manufactured by Bradley, Chicago, Haws, Speakman, Western, Guardian, Acorn Safety, or equivalent.

## **2.02 FAUCETS**

- A. Plumbing fixture faucets shall be brass construction and fully chrome plated, unless special finish is specified on the Plumbing Fixture Schedule on the drawings. Faucets shall be furnished complete with all accessories required for the necessary application, including aerators, handles, spouts, and operating cartridges. Contractor shall coordinate exact faucet requirements with required fixture drilling and water and waste rough-in. Faucets for handicapped fixtures shall meet all handicapped and ADA requirements, including a maximum of five (5) pounds of force to activate controls and adjustable metering faucet water flow duration of ten (10) seconds, minimum. Single hole faucets shall have anti-clocking pin to prevent rotation of valve body.
- B. Plumbing fixture faucets shall be furnished by the fixture manufacturer as specified in the Plumbing Fixture Specification on the drawings and Paragraph 2.1 herein, or shall be as manufactured by Chicago, Delta, Moen, Speakman, T&S Brass, Zurn, or equivalent, and shall be commercial grade.

## **2.03 PLUMBING FIXTURE TRIM**

- A. Plumbing fixture trim including P-traps, supplies, and strainers shall be furnished by the fixture manufacturer as specified in the Plumbing Fixture Specification on the drawings and Paragraph 2.1 herein, or shall be as furnished by Chicago, Brass Craft, McGuire, T&S Brass, EBC, Zurn, or equivalent.

- B. Unless otherwise specified, traps shall be copper-alloy adjustable tube-type with slip joint inlet and swivel, not less than 20 gauge and without cleanout. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level and swivel joints below the discharge level, metal-to-metal or metal-to-plastic type as required for the application. Outlet shall be threaded or socket for solder joint connection as required by the application. Tailpiece shall be copper-alloy, offset style, to match P-trap. Furnish brass or copper wall escutcheon at waste penetration through walls. P-traps, tailpieces, escutcheon, and all piping for above floor exposed installations, including installation within cabinets and casework shall be chrome plated.
- C. Fixture supplies, strainers, and trim shall be brass construction. Supplies shall be commercial grade, quarter-turn all brass ball valves, plastic stems and handles are not acceptable. Furnish supply with loose key unless otherwise specified. Supply pipe shall be 3/8" O.D., with smooth (non-corrugated) flexible copper riser and wall escutcheon. Supply assembly shall be completely chrome plated for all exposed installations, including installation within cabinets and casework. Strainers and other miscellaneous fixture trim shall be furnished as required for the proper installation and shall be chrome plated to match faucets, unless special finish is required.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. The Contractor shall provide all necessary supports and connection materials and trim for plumbing fixtures as required to assure a complete properly installed and operating system. Installation shall be in accordance with manufacturer's recommendations and with International Building Code and International Plumbing Code requirements. The Contractor shall caulk fixtures to the adjacent wall, floor and countertop construction with non-shrink, mildew resistance caulking material.
- B. Fixture mounting height shall conform to the ADA Accessibility Requirements and coordinated with the Architectural drawings.
  - 1. ADA required Water Closet shall be mounted with top of seat 17" – 19" above finished floor.
  - 2. ADA required Urinal shall be mounted at a maximum of 17" top of rim to finished floor.
  - 3. ADA required Lavatory to be mounted with the rim or counter surface no higher than 34" above finished floor.
  - 4. ADA required shower controls shall be located from 38" minimum to 48" maximum height above the shower floor.
  - 5. ADA required Bathtub controls shall be located maximum of 48" above bottom of tub surface.
  - 6. ADA required Sinks shall be mounted with counter or rim no higher than 34" above finished floor.
  - 7. ADA required Drinking Fountains or Water Coolers spouts shall be no higher than 36" measured from the floor or ground surface to the spout outlet.

#### **3.02 EQUIPMENT/FIXTURE SUPPORT**

- A. Furnish and install all "back-up" materials for fixtures and accessories, or as otherwise required by the equipment schedule to properly support and provide a sturdy installation.

### **3.03 FIXTURE CARRIERS**

- A. Fixture carriers shall be provided for all wall hung plumbing fixtures, including water closets, urinals, lavatories, sinks, etc., as manufactured by Josam, Jay R. Smith, Watts, Wade, Zurn, MiFab, or equivalent. Carriers shall be bolted to the floor using all of the support bolts recommended by the manufacturer. Where the water closet nipple and studs extend beyond the maximum carrier recommended length, provide additional carrier support as recommended by manufacturer. Water closet carriers shall be horizontal or vertical, single or back-to-back units as required for the fixture installation and piping arrangement, and shall be adjustable.
- B. Single water closet carriers shall have factory installed rear hold down lugs and anchor foot to provide cantilever support.
- C. Wall hung urinals shall be provided with floor mounted fixture carrier complete with upper and lower fixture support plates as required to match fixture installation requirements.
- D. Wall hung lavatories and sinks shall be provided with floor mounted concealed arm type chair carriers, single or double (back-to-back) units as required for the fixture installation and arrangement.
- E. Contractor shall be responsible to provide the proper arrangement and selection of fixture carriers required for fully concealed installation in the available plumbing chase and/or wall construction.

### **3.04 EQUIPMENT FURNISHED BY OTHERS**

- A. The Contractor shall furnish and install complete rough-in and connections, including stop valves on all supply piping for all mechanical services required for equipment furnished and installed under other sections of this specification, and for all owner-furnished equipment.
- B. Types of equipment in this category shall include but not be limited to the following: kitchen equipment, shop equipment, hospital and laboratory casework, medical equipment, etc. The Contractor shall provide all pipe fittings, unions, traps, connecting wastes, valves, cocks, regulators, pressure reducing valves, flexible connectors, etc., as required for the services to each piece of equipment.
- C. Installation and setting of equipment and fixtures furnished under other Sections of this Specification will not be provided under Division 22 of this Specification, unless otherwise indicated.

### **3.05 FIELD MEASUREMENTS AND COORDINATION**

- A. Exact location and rough-in requirements shall be carefully coordinated. Contractor shall refer to drawings and specifications, and shall check manufacturer's data, shop drawings and rough-in drawing submitted under Division 22 and other Divisions of this specification and make all field measurements to the extent necessary to ensure his understanding of the work required to provide for complete rough-in installation.

### **3.06 CLEANING**

- A. All fixtures shall be thoroughly cleaned before final acceptance of the work.

## **END OF SECTION**

**SECTION 23 05 00**  
**COMMON WORK REQUIREMENTS FOR HVAC**

**PART 1 GENERAL**

**1.01 SCOPE OF WORK**

- A. See General Conditions and Supplemental General Conditions.
- B. The requirements listed under General Conditions and Supplemental General Conditions and the General Requirements are applicable to this Section and all subsequent sections of this Division and form a part of the contract.

**1.02 INDEX OF SPEC SECTIONS FOR THIS DIVISION**

23 05 00	Common Work Requirements for HVAC
23 05 01	Demolition
23 05 02	Installation of Owner-Supplied Equipment
23 05 03	Trenching and Backfilling
23 05 04	Pipe and Pipe Fittings
23 05 05	Piping Specialties
23 05 23	Valves
23 05 48	Vibration Controls for HVAC
23 05 49	HVAC and Electrical Installation Coordination
23 05 50	Variable Frequency Drives
23 05 93	Testing, Adjusting and Balancing of Mechanical Systems
23 07 00	Mechanical Systems Insulation
23 09 00	Facility Management System for DDC Controls
23 21 13	Heating Hot Water System and Equipment
23 21 14	Chilled Water System and Equipment
23 30 00	Air Tempering System and Equipment
23 52 16	Condensing Boilers
23 64 26	Air Cooled Chiller
23 73 13	Indoor Modular Central Station Air Handling Units
23 82 39.13	Cabinet Unit Heaters
23 82 39.16	Propeller Unit Heaters
23 82 39.19	Ceiling Unit Heaters

**1.03 DEFINITIONS**

- A. General: Terms will have meanings as defined in Webster's Eleventh New Collegiate Dictionary except as noted below.
- B. Entities
  - 1. Owner: University of Colorado - Colorado Springs (UCCS)
  - 2. Architect: CSNA Architects
  - 3. Engineer: Bridgers & Paxton

4. Owner's Representative: The Owner will designate his representative after bid. The abbreviation "OR" may be used throughout these specifications to refer to the Owner's Representative.
5. Owner's Agents: The Architect, Engineer, and others authorized to act on behalf of the Owner.

C. Actions

1. Supply: Procure and deliver to the site with all features as specified, required per code, and as required for proper installation. Include submittals, O&M manuals, operator instructions, and warranty.
2. Install: Set in place in accordance with manufacturer's instructions, contract documents, and applicable codes and standards. Coordinate the installation with other disciplines, start, and demonstrate proper operation.
3. Furnish: Supply and install.
4. Provide: Supply and install.
5. Accepted: By the Owner's Representative except as noted.
6. Approved: By the Owner's Representative except as noted.
7. Review: By the Engineer except as noted.

D. Locations

1. Buried: Surrounded by soil or other material, either beneath the building or exterior to the building.
2. Exterior: Exposed to rain or snow. Examples include rooftop locations, spaces around cooling towers, pipe racks, etc.
3. Interior: Not exterior or buried. Examples include not only spaces within the heated envelope of the building, but also unheated attics, covered loading docks in which spaces are protected from rain and snow, utility tunnels, sheds, etc.
4. Finished Spaces: Interior spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated attics, spaces above ceilings, crawlspace, and tunnels.
5. Exposed: Exposed to view. Examples include finished spaces mechanical equipment rooms, rooftops, etc.
6. Concealed: Not Exposed.

E. Other Definitions:

1. 24/7: 24 Hr/day, 7 days per week, year-round.
2. AHJ: Authorities having jurisdiction. The authorities having jurisdiction over this project are established by statute, and include governmentally designated building departments, the fire marshal, fire departments, etc. No attempt is made to list all such entities here; a qualified Contractor is expected to know and coordinate with the various authorities having jurisdiction.
3. FMS: Facility Management System
4. Local: Based no further from the job site than the Engineer is. For example, where the specifications call for a local factory authorized service agent, then on a daily basis that agent must be based in an office or warehouse located no further from the project site than the Engineer's office.
5. OAE: Or approved equal.

#### **1.04 CODES AND PERMITS**

- A. Perform all work in accordance with the 2015 International Building Code, the 2012 International Plumbing Code, the 2012 International Fuel Gas Code, the 2015 International Energy Conservation Code, and the 2015 International Mechanical Code, as adopted and interpreted by the State of Colorado, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. Contractor shall hold and save the Owner and his agents free and harmless from liability of any nature or kind arising from the Contractor's failure to comply with codes and ordinances.
- B. Secure and pay for all permits necessary for performance of the work, including utility connections, extensions, meter pits and meter sets and tap fees for water, storm sewer, sanitary sewer and natural gas, unless otherwise specified herein.
- C. Comply with the requirements of, and the recommendations of:
  - 1. Applicable county and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws and ordinances
  - 2. National Electrical Manufacturer's Association
  - 3. National Electrical Code
  - 4. Underwriters Laboratories
  - 5. American National Standards Institute
  - 6. American Society for Testing Materials
  - 7. Local utility companies
  - 8. National Fire Protection Association
  - 9. ASME Boiler and Pressure Vessel Codes
  - 10. Occupational Safety and Health Administration
  - 11. International Fire Code
  - 12. Midwest Insulation Contractors' Association (MICA)
  - 13. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - 14. American Society of Sanitary Engineering
  - 15. American Gas Association

#### **1.05 PRIOR APPROVAL**

- A. Prior approval (approval prior to bid) of alternate mechanical equipment suppliers and service providers is not required. Please do not request prior approval. Alternate manufacturers and service providers may be submitted after bid in accordance with the submittal process provided they meet or exceed the specifications and the indicated design intent.

#### **1.06 DOCUMENT MANAGEMENT**

- A. The section below describes procedures for handling submittals if a web-based document management system is not used. If a web-based system is used, the procedures below shall be modified as appropriate.

## 1.07 SUBMITTALS

- A. See Division 1 and individual specification sections within this division for additional submittal requirements.
- B. Prior to purchasing materials, equipment and services, submit descriptive literature for review.
- C. See Division 1 and individual specification sections within this division for additional submission requirements. The following describes general submittal procedures. More specific procedures will be established after award. Whenever electronic files are to be submitted, e-mail them through normal channels. But if files are too large to e-mail, then submit them in quantities as described below.
  - 1. Submittal Schedule: Along with the first item submitted for review, include a schedule listing all items to be submitted and an approximate date for each submittal. Submit this schedule in both hard copy and electronic form (Microsoft Excel). Normal review time will be 10 working days or as indicated in Division 1. Schedule should identify any submittals for which expedited review is requested. Update this schedule and resubmit it monthly (by e-mail) for information.
  - 2. Include the following information with each submittal:
    - a. Cover sheet identifying the project name, contractor, architect, engineer, and items included. Indicate symbol numbers, spec section, etc.
    - b. A blank space large enough to accept a review stamp.
    - c. Performance under the specified conditions
    - d. Cover sheet shall clearly identify and **HIGHLIGHT** any ways in which the submitted materials, equipment or services deviate from the Specifications.
  - 3. Quantities:
    - a. Brochures: Submit no more than seven copies plus a PDF.
    - b. Drawings: Submit one reproducible, one print, plus a PDF.
  - 4. Engineer will review one original submittal and one resubmittal for each item. If the Contractor fails to provide the required data or acceptable items with his second submittal, he will be charged for the Engineer's costs for the third and subsequent reviews.
  - 5. Required Information: Submit information to allow the Engineer to easily determine whether the submitted components comply with the general design intent. Include relevant descriptions of materials, features, performance, quality and dimensions. Cross out all features, options and accessories which will not be provided. It is assumed that all specified, indicated and/or required features will be provided unless specifically noted otherwise.
  - 6. Where specifications require a local factory authorized service agent, submit the name, address, and contact information for this agent. Include this information also in the O&M Manual.
- D. Review of Submittals: Engineer will review submittals for general conformance with the design intent.
  - 1. Review of a separate item as such will not indicate review of the assembly in which the item functions.
  - 2. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions, the adequacy of



connections, and the proper and acceptable fitting, execution, functioning and completion of the work.

3. Review will not relieve the Contractor of responsibility to comply with the contract requirements, or responsibility to ensure that equipment fits within the allotted space with required clearances for equipment operation, service and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions and as necessary for proper clearance in front of all electrical panels as defined by the National Electric Code (NEC).
4. For commodity type items (plumbing fixtures, terminal units, registers, diffusers, etc), Engineer will review submittals for type only. Contractor to coordinate sizes and quantities.
5. Actions: Engineer will return submittals with one of the following actions:

NO EXCEPTIONS TAKEN	Contractor may proceed with the work as submitted
EXCEPTIONS AS NOTED	Contractor may proceed with the work and without resubmittal provided he complies with all exceptions noted in the submittal, and so states in a letter
REVISE AND RESUBMIT	Resubmit in accordance with the indicated comments
REJECTED	Resubmit in accordance with the contract documents
RETURNED WITHOUT ACTION	This submittal has not been reviewed, and therefore the Engineer is returning it with no direction to the Contractor.

E. Substitutions:

1. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or if any work is installed in a manner which is not in conformance with the requirements of this specification and for which the Contractor has not received written authorization, remove such unauthorized work and install work in accordance with the contract documents at no change in contract amount.
2. Authorized Substitutions: Provide all accessories and features as required and coordinate substitutions with other disciplines. Bear any extra expenses resulting from the use of substitutions which affect adjoining or related work required in this division or other divisions of the work.
3. If the Contractor substitutes equipment for that indicated on the drawings, he shall prepare a 1/4 inch = 1foot installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will properly fit within the space with adequate clearance for maintenance and replacement. Submit this drawing for review.

- F. Schedule: Submit all submittals in a timely manner consistent with the requirements for completing the work covered by this contract within the prescribed contract time. Be aware that there is risk in ordering components, fabricating work, and/or installing work prior to review. If the Contractor proceeds prior to review, and then the review

comments required modifications to work which has begun or has been completed, then Contractor must comply with the review comments at no change in contract amount or schedule.

G. Shop Drawings

1. Submit shop drawings for
  - a. Mechanical equipment rooms and other spaces housing air handling equipment, heat transfer equipment, fluid handling equipment, machinery, etc.
  - b. Complete supply, return, and exhaust ductwork systems, both exposed and concealed.
  - c. Piping for HVAC, plumbing, and fire protection systems, both exposed and concealed.
2. Show the location and elevation of all equipment, ductwork and piping, as well as openings through slabs and walls. Include plans, elevations and sections as appropriate. Clearly show the manner in which the systems fit into the available space and relate to each other and to the building elements. Indicate required sleeves and openings in general construction elements. Indicate required clearances for operation, maintenance and replacement of operating devices and equipment. Drawings shall be of appropriate scale to facilitate coordination and understanding, but not smaller than 1/4 inch scale for floor plans and 1/4 inch scale for equipment rooms and chases.
3. Conflicts: The engineer has endeavored to work out conflicts in areas where the design is congested, but has not tried to show all required offsets to coordinate with the building construction and building systems, particularly in less congested areas. The intent is that the Contractor coordinate the design of the piping and ductwork distribution systems with the building construction and the various building systems, particularly in less congested areas. Provide experienced designers to perform such services and prepare shop drawings. Exercise good design practice in working out conflicts without compromising system operation or maintenance. Provide fittings, offsets, etc., as required. Contractor shall include this design effort and include the labor and materials for such fittings and offsets in his base bid. Except in extremely unusual circumstances, no additional costs will be allowed related to working out conflicts. Coordinate with other disciplines as required. Identify on the shop drawings those areas where redesign was necessary to resolve design conflicts.
  - a. In the event that the Contractor desires direction in resolving a design conflict or desires prior approval of a recommended approach to resolving a conflict, submit an RFI which identifies the conflict and suggests a recommended solution.
  - b. In resolving conflicts, gravity lines and larger distribution mains will generally have priority over pressurized lines and smaller lines as follows:
    - Plumbing waste and vent lines
    - Roof drains
    - Steam and condensate piping
    - Supply, return and exhaust ductwork
    - Fire sprinkler mains
    - Heating hot water and chilled water piping

Domestic hot and cold water  
Fire sprinkler branch piping and sprinkler runouts  
Pneumatic control piping  
Miscellaneous special piping systems

4. Use of Engineer's CADD Database or BIM Model: The Engineer will provide the Contractor electronic files of the Engineer's CADD Database or BIM Model of the design documents if the Contractor completes and submits the License Agreement form included at the end of this spec section. These files show the general design intent and may be used as a starting point for the Contractor to begin his shop drawings and coordination effort, but the Contractor should not use them as a basis for ordering or fabrication. The normal submittal process still applies, regardless whether the Contractor elects to use the Engineer's CADD Database or BIM Model.

H. Submittals Required under this Specification Section:

1. Electrical Components: Motors, Motor Controllers, and Variable Speed Drives
2. Identification: Products used to identify equipment, ductwork, valves, piping, and control devices.
3. General Construction Components: Roof Curbs & Access doors.

## **1.08 MISCELLANEOUS PROVISIONS**

A. Qualifications

1. All mechanics shall be skilled in their respective trade.
2. All welders shall be certified in accordance with the ASME Boiler Test Code, Section IX, latest issue.

B. Regulated Materials: Comply with all state, local and federal regulations regarding the storage, handling or disposal of oils, lubricants, cleaning agents, refrigerants, other liquids and gases, and hazardous materials.

C. Factory Identification: Provide all materials and equipment with labels sufficient to show compliance with these specifications and the performance requirements indicated on the drawings. All equipment shall carry a permanent label installed by the manufacturer stating that the equipment complies with ASHRAE/IESNA Std. 90.1.

D. Hazardous Conditions: Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

E. Hazard Signs

1. Provide a sign reading, "Hazardous Area - Authorized Personnel Only" on the doors to all equipment rooms, fan plenums, and similar areas containing moving or rotating parts, or other potentially hazardous environments.
2. Provide a sign reading, "Confined Space - Entry by authorized personnel only by permit" for all confined spaces. Confined spaces shall be as designated by OSHA Standard 1910.146. This generally means a space that:
  - a. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
  - b. Has limited or restricted means for entry or exit (for example, tanks, vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and

- c. Is not designed for continuous employee occupancy.
3. Survey the final premises to determine where any potentially hazardous areas exist. If the Contractor feels that hazards exist which cannot be suitably provided for through the above typical methods, he shall forward in writing his concerns, and request for a decision concerning the referenced hazard, prior to the final inspection of the facilities.

#### **1.09 GUARANTEE-WARRANTY**

- A. See Division 1 for additional information on warranties. Warranties shall run for one year from substantial completion unless indicated otherwise.
- B. The following warranty shall be binding:

"The Contractor warrants that this installation is free from mechanical defects. Contractor agrees to replace or repair any part of the installation which may fail within a period of one year after the date established below, provided that such failure is due to defects in materials or workmanship, or to failure to follow the specifications and drawings. This warranty shall begin on the date set forth in the Certificate of Substantial Completion, AIA Form G704, or other such date as documented in writing by the Owner's Representative."
- C. The extent of guarantees or warranties by equipment and/or materials manufacturers will not diminish the requirements of the Contractor's warranty to the Owner.

### **PART 2 PRODUCTS**

#### **2.01 PRODUCT GENERAL REQUIREMENTS**

- A. General: Products supplied under Division 23 shall comply with the following except as noted elsewhere.
- B. Products shall be new; shall be the product of manufacturers regularly engaged in the production of plumbing, heating, ventilating, air conditioning, and control system equipment; and shall be the manufacturer's latest design. Specs and equipment schedules establish expectations regarding standard of quality and operating intent.
- C. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.
- D. Products shall be suitable for the conditions under which they are installed and operated. Prior to or during the submittal phase advise the Owner's representative and the Engineer in writing regarding any concerns about the suitability of the specified products for the intended application or service. Request clarification if any question exists regarding the design intent.
- E. Performance Ratings: Unless otherwise noted, all scheduled equipment performance is based on an elevation of 6180 feet above sea level. Adjust manufacturer's ratings accordingly.
- F. Structural Soundness: Products shall have structural integrity appropriate to the component and its application. Bases shall be rigid and shall keep all components in proper alignment. Structural integrity shall be adequate for both rigging and final installation. Components shall not be loose, rattle, or vibrate unnecessarily in their final installed condition.
- G. Corrosion Resistance: Equipment shall be of materials inherently corrosion resistant, or shall be finished with a corrosion-resistant finish suitable for the location in which the equipment is installed.
- H. Touch-up: If the factory finish of any component is damaged prior to substantial completion, touch up to original condition per manufacturer's recommendations.

- I. Equipment Access Doors or Panels: Provide access doors and panels within equipment to ensure good access to all components requiring inspection, service or maintenance. Provide appropriate hardware. Equipment installed outdoors shall be weather-tight.
- J. Fans: Statically and dynamically balanced, shaft first critical speed shall be above operating speed at design conditions.
- K. Bearings: Grease lubricated or permanently lubricated.
- L. V-Belt Drives: All components sized for 150% of motor HP, multiple belts shall be matched, fixed sheaves for motors 20 Hp and larger, adjustable sheaves for lower HP motors, all safety components for OSHA compliance (e.g., belt guard or other safety provisions) motor mounted on adjustable base. Provide a replacement sheave for each fixed sheave after T&B is complete. Include belt data in O&M manual. Gates Rubber Co, OAE.
  - 1. Belt Guards: Rigidly constructed and attached, removable, galvanized steel, expanded mesh. Design to provide ready access to bearings.
- M. Couplings: Provide coupling guard.
- N. Motors and VFDs: See requirements described elsewhere in this spec section.
- O. Drive Lines (starter or VFD, motor, coupling and shaft or v-belt drive and pulleys, and driven equipment): Coordinate with all suppliers and ensure all components are compatible to work as a system.
- P. Coils: ARI rated, copper tubes mechanically expanded into aluminum fins, galvanized steel casing, drainable, pressure tested to 150% of working pressure but not less than 300 psi.
- Q. Cooling Coil Drain Pans: Provide for all cooling coils, galvanized or stainless steel, double pitched with piped outlet. For units with more than one coil stacked, provide intermediate drain pans piped to the main drain pan.
- R. Gas Burners: Natural gas fired, performance based on gas at 1000 Btu/SCF HHV but suitable for use with gas at 900 – 1050 Btu/SCF and 7 – 11 inches water column, factory installed and pressure tested gas train, all necessary safety and operating controls.
- S. Filter Frames: Galvanized steel, provide wherever filters are specified.
- T. Roof Curbs and Support Rails for Roof-Mounted Equipment: Roof curbs should generally be supplied with the equipment which the curb supports, and shall comply with the requirements of the National Roofing Contractors' Association. Match curb to the requirements of the supported equipment. The roof pitch is indicated on the architectural drawings. If roof pitch exceeds the recommendations of the equipment manufacturer, provide a curb that will level the equipment. Factory fabricated, minimum 12-inch, structurally adequate for the load supported, not less than welded 18-gauge (16-gauge or heavier for sizes more than 50-inches) galvanized steel with minimum 1-inch fiberglass insulation, 2 x 2 wood nailer, and with cant and step if required to match specified roof. Provide damper tray for un-ducted fan applications. Ship small curbs fully assembled; large curbs may be knocked down for shipment.
- U. Electrical & Controls: Except where specifically noted, electric service to each component listed on the equipment schedules will be through a single electrical feed at the voltage indicated on the equipment schedules. Include all components, cabling and conduits to distribute power to all components which are factory supplied and mounted. Provide transformer(s) if required to serve unit-mounted

components requiring electric service at voltages different from the main electric service, including controls components. Provide secondary overcurrent protection. Provide terminal strips for field-installed control wiring. Provide unit-mounted, unit-specific wiring diagrams on durable paper, attached to inside of control panel door or otherwise affixed to the unit. All electrical components shall be UL Listed or Recognized. All factory-installed electrical work shall comply with the NEC unless the overall unit is listed by an organization acceptable to the AHJ, and listed to a standard acceptable to the AHJ.

1. Where equipment includes an LCD or other, similar display for operator interface, display all information in English. Displays should be readily understandable and should not require the user to look up display codes in a reference manual.
2. Provide battery backup to retain all memory and programming, and to keep all clock-related functions powered through a 1-week power outage.
3. Controls interface with the FMS:
  - a. Digital Inputs to FMS: 24V DC sourced from equipment.
  - b. Digital Outputs from FMS: Equipment to have form C relays, max 250V DC, 2 A.
  - c. Analog Inputs to FMS: 4-20 mA, 0-5V DC, or 0-10V DC sourced from equipment.
  - d. Analog Outputs from FMS: 4-20 mA sourced from FMS.

## **2.02 ELECTRICAL COMPONENTS**

- A. General: Except as noted, all electrical products and equipment shall comply with the requirements of this section, whether field installed or factory installed. See "Product General Requirements" and "Installation General Requirements" in Parts 2 & 3 of this spec section for additional requirements.
- B. Motors
  1. General: Except as noted motors shall be horizontal, open drip-proof, 4-pole, 1750 RPM, rated per NEMA MG-1, with fabricated steel or cast iron casing, motor terminal box adequately sized for conductors one-size larger than specified, SS nameplate per NEMA MG-1-20.60, connection diagram attached to motor, compression lugs for power feeds and ground conductor, grease lubricated sealed ball bearings or roller bearings with standard grease fitting zerk and relief tapping, factory lubricated, dynamically balanced to no more than 50% of the NEMA allowable vibration limits. For motors powering V-belt drives, provide a cast iron or steel base with slide rail and adjustable belt tension device. Install motors and equipment on foundations and align as required. 40 deg C rise and total temperature rise of 65 deg C ambient.
    - a. 3/4 hp and smaller: 115V, single phase, 60 Hz, split phase or permanent split capacitor (PSC), NEMA Type N or O, with built-in thermal overload protection.
      - 1) Multi-speed motors.
    - b. 1 hp and greater: 480 V, 3 phase, 60 Hz, squirrel cage induction type, NEMA design B, T-frame, with Class B or F insulation, lifting lugs, 150,000 hr L-10 bearings for direct-coupled applications, 50,000 hr L-10 bearings for belt-driven application with radial loads and pulley sizes per NEMA MG1-14.43.

Service Factor: ODP motors shall be rated for 1.15 SF at 40°C or 1.0 SF at 65°C; TEFC motors shall be 1.0 SF.

- 1) Two speed motors: Provide with two separate windings.
  - 2) Variable speed motors: Drive compatible per NEMA MG1-31, premium efficiency as specified below regardless of Hp, Class F insulation, minimum 5-year warranty.
2. Efficiency: Except as noted, motors shall be premium efficiency type, with nominal efficiencies not less than the following as per the Consortium on Energy Efficiency (CEE), and minimum power factor of 0.85:

HP	Open Drip-Proof (ODP)			Totally Enclosed Fan-Cooled (TEFC)		
	1200 RPM	1800 RPM	3600 RPM	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	80.0	82.5	85.5	78.5
1.5	86.5	86.5	85.5	87.5	86.5	85.5
2	87.5	86.5	86.5	88.5	86.5	86.5
3	89.5	89.5	86.5	89.5	89.5	88.5
5	89.5	89.5	89.5	89.5	89.5	89.5
7.5	91.7	91.0	89.5	91.7	91.7	91.0
10	91.7	91.7	90.2	91.7	91.7	91.7
15	92.4	93.0	91.0	92.4	92.4	91.7
20	92.4	93.0	92.4	92.4	93.0	92.4
25	93.0	93.6	93.0	93.0	93.6	93.0
30	93.6	94.1	93.0	93.6	93.6	93.0
40	94.1	94.1	93.6	94.1	94.1	93.6
50	94.1	94.5	93.6	94.1	94.5	94.1
60	95.0	95.0	94.1	94.5	95.0	94.1
75	95.0	95.0	94.5	95.0	95.4	94.5

3. Approved Manufacturers: General Electric Energy Saver, Baldor Super-E, Marathon Series E, Reliance Electric XE, Westinghouse TEE II, Eaton/Cutler Hammer, Toshiba, Louis Allis, or approved equal.
4. If the Contractor proposes to furnish motors varying in horsepower and/or characteristics from those specified, he shall first submit his request for the change and shall then coordinate the change with all other parties (e.g. electrical contractor) and pay any costs associated with the change.

C. Motor Controllers

Single Phase Manual Starters to 1 Hp and 120-277 V: Cutler Hammer MS with indicating light.

1. 3-Phase: Full voltage, non-reversing, electro-mechanical, combination circuit breaker and motor controller, UL Listed, NEMA rated, 460V, 65,000 AIC, minimum 50 VA 24V controls transformer with secondary overcurrent protection, suitable for operation at -4°F to +149°F and specified voltage -15% to + 10%, adjustable solid

state overloads initially set at Class 10, HOA switch, run indicator, two auxiliary contacts for remote monitoring of status, and enclosure for surface mounting. Cutler Hammer OAE.

- a. Provide enclosure appropriate to the location:
  - 1) NEMA-1 for indoor dry locations.
  - 2) NEMA-3R for outdoors.
  - 3) NEMA-4 for wet applications.
  - 4) NEMA-12 for dusty locations.
  - 5) Explosion-proof – where required.
- b. Motor controllers factory mounted and wired on AC units, boilers, etc, may be definite purpose, and need not have all the features specified here.

### **2.03 ELECTRICAL WIRING AND CONTROL EQUIPMENT**

- A. Provide wiring and conduit as scheduled in Section 23 05 49.
- B. Coordinate with all disciplines to ensure that all necessary components of control work are included and fully understood.

### **2.04 IDENTIFICATION**

- A. Scope: Identify all equipment, ductwork, valves, piping, and control devices shown on the Drawings, identified in the equipment schedules, and indicated in these Specifications. Provide submittals for products and procedures used for identification.
- B. Equipment: For all mechanical equipment supplied or installed under Division 23, provide an equipment identification tag or stencil unit number onto the equipment. Stencils shall be minimum 3-inch height, dark contrasting color, of a material suitable for the application.
  1. For rooftop HVAC equipment, provide a permanently affixed, weather-resistant label to identify the areas served.
- C. Valves: Provide each valve with a stamped metal tag secured to the valve. Tag shall indicate the valve number, service and function. Provide two sets of prints of drawings showing floor plan for each floor with all valves accurately located and labeled. Drawings shall be neat and easily readable. Provide a typed valve chart, listing the valve number, size, location, function, normal operating position, for each valve. List valves by system, i.e., domestic cold water, hot water, chilled water, etc. Tags shall be stamped brass 1-1/2" diameter, and secured to valves by heavy copper figure eight hooks, braided stainless steel wire anchor, or other approved means.
- D. Ductwork: Identify ductwork at or near the fan with stenciled signs on insulated ductwork or engraved laminated plastic signs secured by rustproof screws on un-insulated ductwork. Sign shall identify air conditioning system or fan unit and area served.
- E. Piping
  1. Provide color-coded pipe labels indicating the service of the pipe and the direction of flow. Piping labels shall comply with ANSI Standard A13.1 regarding color coding and size of lettering. The following standardized color code scheme shall be used:
    - a. Yellow - Hazardous Materials.
    - b. Green - Liquid Materials of Inherently Low Hazard.
    - c. Blue - Gaseous Materials of Inherently Low Hazard.
    - d. Red - Fire Protection Materials.



2. Labels shall be vinyl material with permanent adhesive for application to clear dry pipe and/or insulation jacketing. Pressure sensitive pipe tape matching the background color of the label shall be placed over each end of the label and completely around the pipe.
3. Attach pipe markers to lower quarter of the pipe on overhead horizontal runs and on the centerline of vertical piping where view is not obstructed.
4. Provide the following labels, with ANSI/OSHA color and banding for all piping systems as shown on the Drawings and as listed below:

<u>Service/Legend</u>	<u>Letter Color</u>	<u>Background Color</u>	<u>Tape Banding Color</u>
Domestic Cold Water	White	Green	2" Green
Domestic Hot Water	Black	Yellow	2" Yellow
Domestic Hot Water Return	Black	Yellow	2" Yellow
Fire Protection Water	White	Red	2" Red
Fire Auto Sprinkler	White	Red	2" Red
Roof Drain	White	Green	2" Green
Sanitary Sewer	White	Green	2" Green
Storm Sewer	White	Green	2" Green
Natural Gas	Black	Yellow	2" Black
Chilled Water Supply	White	Green	2" Green
Chilled Water Return	White	Green	2" Green
Heating Water Supply	Black	Yellow	2" Yellow
Heating Water Return	Black	Yellow	2" Yellow

5. Locations: Label pipes at the following points on each piping system:
  - a. Adjacent to each valve in piping system.
  - b. At every point of entry and exit where piping passes through a wall.
  - c. On each pipe riser and junction.
  - d. At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
  - e. Adjacent to all special fittings (regulating valves, etc.) in piping systems.
  - f. At every access door.
6. Underground Piping: Provide a continuous, preprinted, bright colored, plastic ribbon cable marker with each underground pipe regardless of whether encased. Locate directly over buried pipe, 6 inches to 8 inches below finished grade. Marker tape used in conjunction with buried plastic piping systems shall be special detector type.

- F. Control System Devices: All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays and starters shall be clearly tagged and identified. Wording shall be identical to that on the control diagram in the Contract Drawings.

## **2.05 GENERAL CONSTRUCTION COMPONENTS**

- A. Roof Curbs and Equipment Support Rails
  - 1. General: Factory fabricated, minimum 12-inch high, galvanized steel, configured to account for roof pitch where pitch exceeds 1/4-inch/ft or where required by manufacturer of supported equipment. Coordinate with roofer and provide cant and step if needed to match roof construction. Actual curb heights to be coordinated by contractor with roofing insulation height to maintain code-required height above final roofing elevation.
  - 2. Roof Curbs: 1.5-inch fiberglass insulation with nominal 2" x 2" wood nailer. Provide damper tray where a damper is indicated. Thycurb TC, Greenheck, RPS, OAE.
  - 3. Equipment Support Rails: Nominal 2" x 4" wood nailer. Thycurb TEMS, Greenheck, RPS, OAE.
- B. Painting: Finish painting of mechanical systems and equipment will be under Spec Section 09 9100, "Painting," unless equipment is specified to be provided with factory-applied finish coats.

## **2.06 MISCELLANEOUS PROVISIONS**

- A. Flow Diagrams: Provide half-size prints of each system flow diagram, including air handling, chilled water, heating water, domestic water, domestic HW, etc. Mount framed under plexiglass, and locate either on the associated AHU or on a nearby wall. Incorporate any as-built revisions.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION GENERAL REQUIREMENTS**

- A. Cooperation with Other Trades: Refer to other parts of these Specifications covering the work of other trades which must be carried on in conjunction with the mechanical work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. Be responsible for the size and location of all openings, foundations, etc.
- B. Trenching and Backfilling: Provide all excavation, trenching and backfilling required for the installation of the work of this division.
- C. Manufacturer's Instructions: Install all products in accordance with manufacturers' recommendations and the requirements of any applicable listings. If manufacturers' recommendations and/or requirements of applicable listings conflict with plans and specifications, report such conflicts to the Owner's Representative.
- D. Field Measurements: Verify all dimensions and conditions governing the work. Examine adjoining work on which the work of this Division is dependent, and report any deficiencies.
- E. Do not compromise the building structural, fire resistant construction or vapor barrier system.
- F. Supports for Equipment and Systems: Foundations and structural supports for equipment will generally be provided by others. The contractor for this division shall provide supplementary supports as required to support equipment, distribution systems, and other components installed under this division. Prior to installing mechanical work, examine foundations and supports to ensure they are adequate to

properly support the equipment. Provide all necessary foundations, structures, supports, inserts, sleeves, etc, for installation of mechanical and plumbing equipment, ductwork and piping, etc. Coordinate installation of such devices with all disciplines. Verify that the devices and supports are adequate as intended and do not overload the building structure.

- G. Concealed or Buried Work: For work which is underground or which will be concealed by building construction, provide digital photographs to document the installation throughout the construction project, but not less than weekly. Include plans indicating where the photographs were taken. Notify the OR of when the work will be complete and provide OR a minimum five-day period to inspect the work after completion but prior to when it is backfilled or concealed by building construction.
- H. Access Doors: Provide as required for access to valves, dampers, controls, or other items for which access is required for either operation or servicing. The type of access door shall be as required by the room finish schedule.
- I. Alignment of Flexible Couplings: Flexible couplings between motors and driven equipment shall be aligned by a qualified service technician after the equipment is installed and ready for operation. Align equipment per manufacturer's recommendations under operating conditions and temperature. Provide written certification that each device has been so aligned.
- J. Lubrication: Provide all oil for the operation of all equipment until acceptance. Be responsible for all damage to bearings while the equipment is being operated by Contractor up to the date of acceptance of the equipment. Protect all bearings and shafts during installation and thoroughly grease shafts to prevent corrosion. Bearings for items of mechanical equipment shall be marked at each bearing location as to whether the bearing is a sealed type or relubricable type unit.
- K. Tests: All tests shall be conducted in the presence of the designated and authorized Owner's Representative. Notify the Owner's one week in advance of all tests. Requirements for testing are specified under the sections covering the various systems. Provide all necessary equipment, materials, and labor to perform the required tests.
- L. Protection of Material and Equipment:
  - 1. Protect all work, materials and equipment furnished and installed under Division 23, whether incorporated in the building or not.
  - 2. All items of mechanical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner as approved.
  - 3. Protect all work and be responsible for all damage done to property, equipment and materials. Coordinate material storage with the Owner's Representative.
  - 4. Pipe and duct openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. Plumbing fixtures shall not be used by the construction forces. At the completion of the work clean and polish fixtures, equipment and materials prior to turning them over to the Owner.

### **3.02 DRAWINGS**

- A. The drawings show the general arrangement of the piping, ductwork, equipment, etc. Follow them as closely as actual building construction and work of other trades will permit. Where discrepancies occur between Plans and Specifications, the more stringent shall govern. All Contract Documents shall be considered as part of the work. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories, which may be required, and no attempt has been

made to do so. Rather, the drawings convey the general design intent. Investigate the structural and finish conditions affecting the work and arrange the work accordingly, providing fittings, valves, and accessories as required to meet such conditions. Show any such changes on the Record Drawings.

- B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, submit an RFI.
- C. Install equipment, piping, ductwork, and electrical systems with proper clearance for operation, service, and maintenance, including minimum clearances required by applicable codes, manufacturer's installation instructions, etc. Include proper clearance in front of and above electrical equipment as defined by the National Electric Code (NEC). Piping and ductwork systems shall not be routed through or above electrical equipment rooms, telecommunications rooms, elevator machine rooms, or electrical equipment spaces within mechanical equipment rooms.
- D. Arrange all concealed mechanical systems carefully to fit within the available space without interference with adjacent structural and electrical systems. Make all necessary provisions for penetrations of piping and ductwork, including sleeves and blockouts in structural systems. The exact location of all exposed mechanical systems, including grilles, registers, and diffusers; access doors; sprinkler heads; piping and ductwork exposed within finished areas; and other equipment and devices as applicable, shall be coordinated with the Architect, who shall have final authority for the acceptance of the work as it relates to the aesthetic design for the facility.

### **3.03 INTERRUPTING SERVICES**

- A. Coordinate the installation of all work within the building in order to minimize interference with the operation of existing building mechanical, plumbing, fire protection, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without written review and authorization.

### **3.04 CONCRETE BASES AND HOUSEKEEPING PADS**

- A. Concrete bases and housekeeping pads shall be installed under all pieces of mechanical equipment unless specifically deleted by the Specifications or Drawings.
- B. Be responsible for the accurate dimensions of all pads and bases and furnish and install all vibration isolators, anchor bolts, etc.
- C. Provide concrete housekeeping pad foundations for all floor mounted equipment installed under this section unless otherwise shown on the Drawings. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these Specifications. Pad foundations shall be 4 inches high minimum, unless otherwise indicated on the Drawings. Chamfer edges shall be 1 inch. Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. Provide dowel rods in floor for lateral stability and anchorage.
- D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1 inch larger than bolt diameter. Anchor bolts shall be high strength steel J-shape. Anchor bolt design shall be arranged and paid for by the Contractor.

- E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, and then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

### **3.05 PRESSURE RELIEF DEVICES**

- A. Refrigerant pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with ANSI/ASHRAE Standard 15. Discharge shall be to atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit from any building. Discharge line sizing shall conform to ANSI/ASHRAE Standard 15-1994.
- B. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

### **3.06 INSTALLATION CHECK**

- A. An experienced, competent, and authorized representative of the equipment listed below shall visit the site of the work and inspect, check, adjust if necessary, and approve the installation for the equipment listed below. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is approved and accepted.
- B. Each equipment supplier's representative shall furnish a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.
- C. Equipment requiring installation check includes the following:
  - Chillers
  - Pumps 25 hp and larger
  - Boilers
  - Air Handling Units
  - Fans over 25 hp
  - Humidifiers
  - Facility Management System (See Specification Section 23 0900)

### **3.07 OPERATION PRIOR TO ACCEPTANCE**

- A. Operation of equipment and systems for the benefit of the Owner prior to substantial completion will be allowed provided that a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.
- B. Operation of equipment and systems for the benefit of the Contractor, except for the purposes of testing and balancing, will not be permitted without a written agreement between the Owner and the Contractor establishing warranty and other responsibilities.

### **3.08 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS**

- A. At completion of the project provide two complete bound sets of the following documents, along with two CDs containing searchable PDFs of these documents. Organize bound information in a logical fashion with a table of contents and tabs for the different sections. Organize PDFs in a logical fashion with bookmarks to assist the

operating personnel in retrieving desired data. Provide minimum two 1-hour sessions to instruct Owner's facility personnel in how to find information in the bound O&Ms and the PDFs. Take attendance and submit the attendance list to the Owner's Representative. Include the following:

1. Approved Submittals.
  2. Test reports.
  3. O&M manuals and instructions covering all equipment supplied under this Division, with all non-applicable information crossed out. Clearly identify all required routine maintenance. Include parts lists.
  4. A master Lubrication Chart listing each piece of equipment, the recommended oil or grease, and the recommended frequency of lubrication.
  5. The names and addresses of at least one service agency capable of providing required maintenance for each item of equipment supplied.
  6. Complete temperature control diagrams including control descriptions, system sequence of operation, operating instructions, control system maintenance and calibration information, wiring diagrams, and all control setpoints. See Section 23 0900 for additional requirements.
- B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.
- C. Submit O&M manuals for review and distribution to the Owner not less than two weeks prior to the date scheduled for O&M instructions as specified.
- D. Demonstrate proper system operation to the owner's operating staff. Provide the services of the contractor and subcontractors (e.g., mechanical, T&B, temperature control, etc), as required to properly demonstrate system operation.
- E. Provide the necessary skilled labor and helpers to operate the mechanical systems and equipment for a period of 2 days of eight hours each. During this period, instruct the owner's facility staff fully in the operations, adjustment and maintenance of all equipment provided. Provide at least two weeks advanced notice, with a written schedule of each training session, the subject of the session, the Contractors' Representatives who plan to attend the session, and the time for each session. Take attendance and submit attendance sheets to the Owner's Representative.
- F. Film the instruction and training sessions submit two copies of the DVD.

### **3.09 RECORD DRAWINGS**

- A. See Division 1, for additional requirements associated with Project Record Drawings.
- B. Maintain a full-size set of marked-up prints showing the installed location and arrangement of all work under this division, and in particular where changes were made during construction. Keep record drawings accurate and up-to-date throughout the construction period. Owner's Agents may request to review record drawings during construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFIs, bulletins, and change orders neatly taped or attached to record drawing set. At the completion of the project send the Engineer full-size plans clearly showing all changes from the original design marked up in red so as to facilitate the Engineer incorporating these changes into the Engineer's CADD files. Forward record drawings to the Owner's Representative prior to submitting a request for substantial completion.

### **3.10 SITE VISITS AND OBSERVATION OF CONSTRUCTION**

- A. The Engineer may make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the work so as to determine if such work is proceeding in general accordance with the Contract Documents. This observation will not release the Contractor from his responsibility to supervise, direct, and control all construction work and activities. The Engineer has no authority over, or responsibility for means, methods, techniques, sequences, or procedures of construction or for safety precautions and programs, or for failure of the Contractor to comply with applicable laws, regulations, or codes.
- B. Prior to substantial completion, request that the Engineer provide a final observation visit. Complete the attached "Final Observation Checklist," and include it with this request. For any items that are not applicable, mark them "N/A."

### **3.11 PROJECT CLOSEOUT**

- A. Submit written certification that all work complies with the specifications and applicable codes. Submit certifications and acceptance certificates including proof of delivery of record drawings, O&M manuals, spare parts required, and equipment warranties.

**END OF SECTION**

Project: \_\_\_\_\_ Date Submitted: \_\_\_\_\_  
 General Contractor: \_\_\_\_\_ Date of Final Mechanical System: \_\_\_\_\_  
 Mechanical Contractor: \_\_\_\_\_ Observation Requested: \_\_\_\_\_

CONTRACTOR'S MECHANICAL & PLUMBING CHECK LIST

(ALL APPLICABLE ITEMS MUST BE COMPLETED PRIOR TO FINAL OBSERVATION)

In advance of requesting a final mechanical observation for installed mechanical systems, please check all items that have been completed. For all items not applicable to this project mark N/A.

PLUMBING/PIPING

- \_\_\_\_ 1. All plumbing fixtures are set, sealed and cleaned.
- \_\_\_\_ 2. All domestic and HVAC pipe systems are insulated.
- \_\_\_\_ 3. All pipe systems are identified with specified labels and directional arrows.
- \_\_\_\_ 4. Floor sinks and drain grates are cleaned and debris removed.
- \_\_\_\_ 5. Valve tags are installed.
- \_\_\_\_ 6. Special equipment (water softeners, water heaters, piping systems, etc.,) have been checked and put into service.
- \_\_\_\_ 7. Medical gas systems have been checked and certified.
- \_\_\_\_ 8. Special piping systems have been cleaned and pressure tested.
  - \_\_\_\_ Fuel Handling                      \_\_\_\_ Process Piping
  - \_\_\_\_ Compressed Air                      \_\_\_\_ Nitrogen
  - \_\_\_\_ Natural Gas                              \_\_\_\_ Vacuum
  - \_\_\_\_ Other                                      \_\_\_\_ Argon
  - \_\_\_\_ Medical Gas
  - \_\_\_\_ Other
- \_\_\_\_ 9. Limestone chips have been installed in acid dilution sumps.
- \_\_\_\_ 10. Plumbing/piping connections have been completed to Owner-furnished equipment and equipment furnished by other Contractors/Subcontractors.
- \_\_\_\_ 11. Exterior wall hydrants have been cleaned.
- \_\_\_\_ 12. Concrete collars have been installed at clean-out to grade, valve box, or other specified plumbing items.
- \_\_\_\_ 13. Drains and relief lines from plumbing and HVAC equipment have been installed and secured in a proper manner.
- \_\_\_\_ 14. All plumbing equipment and areas of equipment have been cleaned and debris removed.
- \_\_\_\_ 15. All plumbing equipment required by the Specifications has been identified and/or numbered.
- \_\_\_\_ 16. Domestic water systems sterilization has been completed.
- \_\_\_\_ 17. Refrigerant piping/system has been charged and tested.
- \_\_\_\_ 18. Strainers/suction diffusers have been cleaned.



- \_\_\_\_\_ 19. Backflow preventers have been tested.
- \_\_\_\_\_ 20. Air has been vented from all coils and systems.
- \_\_\_\_\_ 21. Water treatment systems have been charged and tested.
  - \_\_\_\_\_ Chilled Water
  - \_\_\_\_\_ Hot Water
  - \_\_\_\_\_ Steam
  - \_\_\_\_\_ Condensate
  - \_\_\_\_\_ Fire Protection
  - \_\_\_\_\_ Sanitary Sewer and Vent
  - \_\_\_\_\_ Roof and Overflow Drains
  - \_\_\_\_\_ Condenser Water
  - \_\_\_\_\_ Steam/Condensate
  - \_\_\_\_\_ Domestic Hot Water
  - \_\_\_\_\_ Domestic Cold Water
  - \_\_\_\_\_ Acid Waste and Vent
  - \_\_\_\_\_ Heat Recovery Piping
  - \_\_\_\_\_ Other (list)
- \_\_\_\_\_ 22. Ethylene glycol system has been charged with correct mixture and tested.
- \_\_\_\_\_ 23. Water systems have been cleaned (X) and pressure tested (P)
- \_\_\_\_\_ 24. PRVs have been adjusted (water, steam, gases).

FIRE PROTECTION

- \_\_\_\_\_ 1. Fire protection piping is completed.
- \_\_\_\_\_ 2. Fire protection system has been certified by the Fire Marshal's office.
- \_\_\_\_\_ 3. All electrical interlocks between the fire sprinkler components and the fire panel have been checked for operation.
- \_\_\_\_\_ 4. Spare sprinkler head, wrench and cabinet are installed.

HVAC - EQUIPMENT AND DUCTWORK

- \_\_\_\_\_ 1. All ductwork has been sealed and insulated.
- \_\_\_\_\_ 2. Return air paths and transfer openings have been verified.
- \_\_\_\_\_ 3. Air handlers have been cleaned inside and out and construction filters removed and replaced with final filters.
- \_\_\_\_\_ 4. All air handling equipment has been started and operated for the specified time.
- \_\_\_\_\_ 5. All equipment isolators have been adjusted for specified deflection.
- \_\_\_\_\_ 6. All VAV boxes, fan coils, or fan powered boxes are completed and operational.
- \_\_\_\_\_ 7. All pump shafts and couplings have been aligned.
- \_\_\_\_\_ 8. Ductwork, coils, housing, diffusers, registers and grilles have been cleaned.
- \_\_\_\_\_ 9. Boilers have been fired and certified by the supplier.
- \_\_\_\_\_ 10. Cooling towers have been started and inspected by the supplier.
- \_\_\_\_\_ 11. Chillers have been charged, started and certified for operation by the supplier.
- \_\_\_\_\_ 12. Fire dampers are accessible and fully operational.
- \_\_\_\_\_ 13. All HVAC equipment has been lubricated.
- \_\_\_\_\_ 14. HVAC equipment has been labeled in accordance with the Specifications.

- \_\_\_\_\_ 15. Duct pressure testing is complete and accepted.
- \_\_\_\_\_ 16. "HAZARDOUS AREA" signs installed where applicable.
- \_\_\_\_\_ 17. Belt guards installed where applicable.
- \_\_\_\_\_ 18. Variable frequency drives have been tested by the manufacturer's representative and certified to be in compliance with all of the specified requirements.
- \_\_\_\_\_ 19. Testing and balancing has been completed, and deficiencies noted have been corrected.
- \_\_\_\_\_ 20. Special systems have been started and tested, such as: Humidification, laboratory hoods, kitchen hoods, and Owner-furnished items.

TEMPERATURE CONTROLS

- \_\_\_\_\_ 1. Temperature control panels and devices have been labeled in accordance with the Specifications.
- \_\_\_\_\_ 2. All control dampers close completely and edge and blade seals form tight seal.
- \_\_\_\_\_ 3. All control valves have been piped as required by the Drawings.
- \_\_\_\_\_ 4. Controls systems are completed and all control points are operating and recording properly.
- \_\_\_\_\_ 5. All temperature control tubing and wiring is installed and secured in accordance with the Specifications and the electrical code.
- \_\_\_\_\_ 6. Smoke removal fans and/or smoke detectors have been tested for operation and shutdown.
- \_\_\_\_\_ 7. Freezestats have been tested ensuring fan shutdown and full damper closure.
- \_\_\_\_\_ 8. Operator training for temperature controls has taken place.
- \_\_\_\_\_ 9. Refrigerant sensors and equipment room shutdown have been tested.

GENERAL ITEMS

The following specified items have been submitted:

- \_\_\_\_\_ 1. Record Drawings (to be submitted prior to final payment to the Contractor).
- \_\_\_\_\_ 2. Operation and maintenance manuals.
- \_\_\_\_\_ 3. Manufacturer's representative installation check and certification submitted (see list of equipment, Section 23 0500).
- \_\_\_\_\_ 4. Testing and balancing reports.
- \_\_\_\_\_ 5. Test kits furnished to Owner.
  - \_\_\_\_\_ Flow Measuring Devices
  - \_\_\_\_\_ Flow Balance Valves
  - \_\_\_\_\_ Flow Control Devices
- \_\_\_\_\_ 6. Temperature control schematics and sequence of operation.
- \_\_\_\_\_ 7. Wall-mounted lubrication, valve, and temperature control charts have been installed.

## LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL

**PROJECT:** \_\_\_\_\_

**LICENSE GRANT:** Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

**COPYING RESTRICTIONS:** Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

**WARRANTY:** Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

**INDEMNITY:** Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

**ACKNOWLEDGMENT:** Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

### CONTRACTOR'S REPRESENTATIVE

Signature: \_\_\_\_\_ Company Name: \_\_\_\_\_

Name: \_\_\_\_\_ Address 1: \_\_\_\_\_

Title: \_\_\_\_\_ Address 2: \_\_\_\_\_

Date: \_\_\_\_\_



## **SECTION 23 05 01**

### **DEMOLITION**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

##### **1.02 RELATED SECTIONS**

- A. See Section 23 05 00, for Common Work Requirements for HVAC.
- B. See Division 1, for Cutting and Patching.

##### **1.03 SCOPE OF WORK**

- A. The terms "demolish" and "remove" shall mean disconnect, cart away, and dispose of off site. Components to be demolished or removed include all materials, equipment, building construction, and other components as indicated. Components to be demolished shall become the property of the contractor, and contractor may dispose of them by either landfilling or by selling salvageable parts and recyclable materials to legitimate third parties.
- B. Except as specifically noted, asbestos abatement will be by others, and is not included in this contract. Advise the Owner sufficiently in advance of demolition work so that Owner may arrange to have asbestos removed without delaying demolition or construction work.
- C. The Owner retains the first right of refusal on all components to be removed. When requested, remove components carefully and deposit components in locations as directed by the Owner.

#### **PART 2 PRODUCTS**

Not Applicable.

#### **PART 3 EXECUTION**

##### **3.01 GENERAL**

- A. Within four weeks after notice to proceed, and a minimum of two weeks prior to any demolition activities, submit a project schedule indicating all demolition work. Schedule all work to minimize interruptions in utility services to the facility. Interruptions generally will be allowed only outside normal operating hours. Sequence all work in accordance with the drawings and the Project Manual.
- B. Take care not to damage equipment, materials, components, and building construction which is to remain in service. Provide blind flanges, caps, etc, so as to prevent accidental discharge of water, etc.
- C. Do not interfere with the Owner's access to buildings and equipment. If any activities cause interference which is objectionable to the Owner, contractor shall modify his means and methods, or reschedule those activities outside occupied hours at no additional cost to the Owner.
- D. Where existing systems must remain in service during the construction project, make whatever provisions are necessary to accomplish this. This includes providing blind flanges and caps, temporary insulation, duct caps, etc, to allow for proper system operation.

### **3.02 EQUIPMENT**

- A. General: Disconnect and remove piping, ductwork, controls, power, and equipment supports. Wherever possible, remove equipment as a whole. Do not cut up equipment in place unless approved in advance by the Owner.
- B. Chillers: Drain water in evaporator and condenser to sanitary sewer system. Remove refrigerant and either recycle or dispose of as a hazardous material. Remove oil and dispose of as a hazardous material. Comply with all applicable regulations, including the Clean Air Act and RCRA. Submit documentation showing final owner and location of refrigerant and oil.
- C. Boilers: Water in boiler, condensate system, and boiler feed system may be drained to the sanitary sewer system. Remove boilers, steam piping, blowdown systems, condensate piping, condensate pumps, boiler feed pumps, safety relief piping, breeching, stacks, and all associated piping and accessories. Repair concrete floor. Remove chemicals and chemical feed equipment. Chemicals shall be either reused by chemical supplier, or properly disposed of in accordance with all applicable regulations including RCRA. Submit documentation showing final owner, location, and means of disposal for chemicals.
- D. Cooling Tower: Drain water to sanitary sewer system. Disassemble tower as required, cart away, and dispose of all components. Wood members shall be disposed of as hazardous materials. Comply with all applicable regulations, including RCRA. Submit paperwork documenting the final owner, location, and means of disposal for all wood members. Demolish and cart away the concrete basin for the cooling towers and condenser water pumps. Backfill with approved fill material to grades which will ensure proper drainage. Compact to 95% Standard Proctor Density. Restore surfaces as indicated.

### **3.03 PIPING**

- A. Disconnect piping as indicated, and remove all piping not required in the final, upgraded condition of the systems. This includes removal back to the headers and mains which must remain in service. The existing valving may not hold tight. Arrange in advance for shutdowns as required. Provide caps, blind flanges, etc. as indicated on drawings, as required to facilitate construction activities, and as required to facilitate owner's use of the system.
- B. Remove all components in piping system, including valves, fittings, flanges, strainers, anchors, guides, hangers, supports, supplementary steel, attachments to structure, instrumentation, insulation, etc.
- C. Patch all openings in walls, floors, roofs, partitions, gratings, etc, which remain after piping is removed.
- D. Provide vents and drains in the piping which will remain in service, where necessary to facilitate refilling, venting, and future system operation.

### **3.04 DUCTWORK**

- A. Disconnect ductwork as indicated, and remove all ductwork not required in the final, upgraded condition of the systems. This includes removal back to the mains which will remain in service. Arrange in advance for shutdowns as required. Provide caps as indicated on drawings, as required to facilitate construction

activities, and as required to facilitate the Owner's temporary and final use of the systems.

- B. Remove all components in ductwork system including fittings, dampers, grilles, registers, diffusers, louvers, hangers, supports, supplementary steel, attachments to structure, instrumentation, insulation, acoustic lining, etc.
- C. Patch all openings in walls, floors, roofs, partitions, gratings, etc, which remain after ductwork is removed.

### **3.05 CONTROLS**

- A. Remove all controls associated with equipment, piping and ductwork which are to be removed. Controls shall include instrumentation, control panels, wiring, conduits, tubing, supports, and attachments to structure. Where wiring is run in conduit in concealed locations, remove the wiring, cap both ends of conduit, and label conduit as "ABANDONED" at both ends.

### **3.06 ELECTRIC POWER**

- A. Remove all electric power associated with equipment, controls and accessories which are to be removed. Electric power shall include starters, disconnects, wiring and conduit from MCC's and distribution panels to local starters and disconnects, wiring and conduit from local starters and disconnects to equipment, supports, attachments to structure, and concrete housekeeping pads. Label all associated breakers as "SPARE." Where MCC's serve equipment to be removed and no new equipment is to be served from the same starter, leave the starter in place and label it as "Spare Size X Starter."
- B. Where wiring runs in conduit within concealed locations, remove the conductors, cap both ends of conduit, and label conduit as "ABANDONED" at both ends. Where wiring runs below grade, remove conductors, cap conduit at both ends, and abandon in place. Where wiring runs below concrete floor slabs, chip out concrete around conduit, remove conduit to bottom of slab level, and patch floor to match adjacent surfaces.

### **3.07 EQUIPMENT SUPPORTS**

- A. Housekeeping Pads: Remove housekeeping pads for equipment to be removed. Remove all tripping hazards and resurface floor to match surrounding floor.
- B. Equipment Foundations: Remove foundations, remove all tripping hazards, backfill as required, compact to 95% Standard Proctor Density, and pour floor slab to match existing.
- C. Support Steel: Remove all support steel including attachments to building or to grade.

### **3.08 MEANS OF ACCESS**

- A. Remove all service platforms, catwalks, ladders, etc. which are required solely for the equipment, valves, and instrumentation which are being removed as part of this work.

**END OF SECTION**





## **SECTION 23 05 03 TRENCHING AND BACKFILLING**

### **PART 1 GENERAL**

#### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and the General Requirements.

#### **1.02 SCOPE OF WORK**

- A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the HVAC work specified herein under Division 23.
- B. Provide the services of a qualified underground locator to field locate and mark all existing buried utility lines, public and private, piping, conduits, etc., within the required construction area prior to the start of any trenching or excavation work.

#### **1.03 SAFETY REGULATIONS**

- A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplemental General Conditions and Safety Requirements for this type of work.

### **PART 2 PRODUCTS**

Not Applicable.

### **PART 3 EXECUTION**

#### **3.01 TRENCHING AND BACKFILLING**

- A. **General Excavation:** The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated material not required or suitable for backfill shall be removed and wasted. Berming and grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Sheeting and shoring shall be done as required for the protection of the work and for the safety of personnel.

**Trench Excavation:** Trenches shall be of adequate width for the proper laying of the pipe, and the banks shall be as nearly vertical as practicable and safe for workmen. The bottom of the trenches shall be accurately graded and bedded to provide uniform bearing and support for each section of the pipe at every point along its entire length. Bell holes and depressions for joints shall be dug after the trench bottom has been graded, and bedded in order that the pipe rests upon the prepared bottom for as nearly its full length as practicable. Care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 4 inches below the trench depths indicated on the drawings or specified. Overdepths in the rock and common excavation shall be backfilled with coarse sand, fine gravel, or otherwise suitable material. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable materials, as hereinafter specified.

- B. The Contractor shall move trucks and equipment on prescribed roads and keep the roads free from mud, dirt and spillage.
- C. If additional material is needed for fill on the project, it shall be furnished by the Contractor.
- D. Bracing and Bulkheading: In all excavation work the Contractor shall provide necessary underpinning, bracing, or bulkheading to safeguard the work, the present structures, workmen, the public, and the property, and shall assume all responsibility in connection therewith.
- E. Backfilling: The trenches shall not be backfilled until all required pressure tests are performed and until the utilities as installed conform to the requirements specified. The trenches shall be carefully backfilled with materials approved for backfilling; free from large clods of earth or stones. The entire depth of trench shall be backfilled in layers, and each layer shall be spread evenly, wetted to optimum moisture and thoroughly mixed to uniform consistency and compacted to the required maximum density obtainable as the same soil, as determined by ASTM D698.
- F. All imported fill required under this section will be furnished by the Contractor. Imported fill will be base course material approved for use by the State Highway Department.
- G. Fill material shall be free from trash, lumber or any type of debris which may be detrimental to producing the required density in the fill.
- H. The earth beneath all sidewalks and concrete slabs shall be backfilled and compacted to at least 8" below any gravel or sub-base material before the placement of gravel or other base material and shall be coordinated with requirements contained within Division 2.
- I. All piping not encased in concrete shall be bedded in sand or fine gravel, without rocks or other foreign material. Bedding material shall be placed around the pipe in accordance with manufacturer's recommendations. The bedding material shall be distributed around pipe to assure full consolidation.
- J. In grass and planted areas, the Contractor shall backfill his excavation to approximately 8" below finished grade. Contractor shall coordinate backfill requirements contained in Division 2.
- K. The Contractor shall protect from damage all existing underground utilities indicated on the Contract Drawings or field located by underground utility locator service prior to excavation operations. Any damage to such existing utilities shall be repaired by the Contractor without additional costs to the Owner.
- L. Provide density test for trench, backfill in accordance with Division 2 requirements.

### **END OF SECTION**

## **SECTION 23 05 04**

### **PIPE AND PIPE FITTINGS**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.
- B. Lead Ban: All systems and system components, pipe, fittings, and fixtures furnished under Division 23 shall be lead free.
  - 1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
  - 2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

##### **1.02 RELATED SECTIONS**

- A. Section 23 05 00, Common Work Requirements for HVAC.

##### **1.03 SUBMITTAL DATA**

- A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

#### **PART 2 PRODUCTS**

##### **2.01 PIPE AND PIPE FITTINGS**

- A. Piping system materials shall be furnished as specified under the Sections describing the various piping systems. Pipe fittings shall be compatible with the piping systems in which they are installed.
- B. Pipe fittings for steel piping systems shall be weld, screwed or mechanical couplings. Butt weld fittings shall be manufactured by Weld-Bend, Laddish, or equivalent, standard or extra strong as specified in the applicable Sections of this Specification, conforming to ANSI Standard B16.9. All 90° weld elbows shall be long radius unless otherwise specified. Wherever tee connections are required in the piping system, manufacturer's straight or reducing tees shall be utilized. The use of fittings formed from welded pipe or pipe sections will not be permitted. Forged steel "Weld-O-Lets", "Branch-O-Lets", and "Thred-O-Lets", as manufactured by Bonney Forge or equivalent, may be utilized for welded branch and tap connections up to one-half the size of the main. Forged steel half-couplings conforming to ANSI B16.11 may be used for drain, vent and gauge connections. Flanges shall be forged steel weld neck or slip-on, raised face, Class 150 or 300 as specified in the applicable Sections of this Specification with full face or ring type non-asbestos gasket material suitable for the application.
- C. Socket weld fittings shall be Schedule 40, 2000 pound or Schedule 80, 3000 pound construction, as specified in the applicable Sections of this Specification, conforming to ANSI B16.11, as manufactured by Grinnell or equivalent.
- D. Screwed fittings shall be Class 150 standard or Class 300 extra heavy, black or galvanized, malleable iron or cast iron, as specified in the applicable Sections of this Specification, as manufactured by Grinnell or equivalent. Screwed malleable iron fittings shall conform to ANSI B16.3 and cast iron screwed fittings shall conform to ANSI B16.4. Bushing reduction of a single pipe size or use of close nipples will be permitted.

- E. Pipe couplings and fittings as manufactured by Victaulic, Tyco-Grinnell, or equivalent may be utilized for steel piping systems in lieu of butt weld fittings, as specified in the applicable Sections of this Specification. Couplings shall consist of ductile or malleable iron housing, with gasket, and nuts and bolts required to secure the unit. Gaskets shall be molded of synthetic rubber or other compound as recommended by the manufacturer for the fluid application including required pressure and temperature operating ranges. Fittings utilized in conjunction with Victaulic type piping system shall be manufacturer's full flow cast iron, malleable iron, or steel fittings with grooves designed to accept mechanical couplings. All piping shall be prepared in accordance with manufacturer's specifications, furnished for factory or field installed roll grooves without metal removal. Square cut grooves will not be permitted. Assembly of couplings, fittings and piping shall be in accordance with manufacturer's published instructions. Gaskets, pipe ends, fittings and coupling housings shall be properly lubricated with water-based type lubricant furnished by the coupling manufacturer. Couplings shall be Victaulic Style 07 "Zero-Flex" or equivalent, rigid coupling through 24" size. For applications in conjunction with connections to items of equipment such as boilers, water chillers, cooling towers, etc., Victaulic Style 75 or equivalent couplings shall be utilized. Adapter connections between Class 125 and 150 flanged components and grooved piping system shall be made utilizing Victaulic Style 741 and 742 or equivalent flange adapter. Branch and tap connections up to one-half the size of the main may be made utilizing Victaulic Style 72 or equivalent outlet couplings and Style 920 or 921 or equivalent branch outlet connections.
- F. Pipe fittings for copper piping system shall be wrought copper conforming to ANSI B16.22. Cast brass fittings conforming to ANSI B16.23, may be utilized for sanitary drainage, waste and vent systems, HVAC gravity condensate drainage system, and other non-pressure applications.
- G. Bronze flanges, Class 125 and Class 150, shall conform to ANSI B16.24.
- H. Cast iron fittings for cast iron sanitary soil, waste, and venting piping systems shall be as specified in Division 22.
- I. Ductile iron fittings for ductile iron water service piping systems shall be as specified in Division 22.

## **2.02 FLOOR, WALL AND CEILING PLATES**

- A. Where uncovered, exposed pipes pass through finished floors, finished walls, or finished ceilings, they shall be fitted with chromium plated spun brass escutcheon plates. Plates shall be large enough to completely close the hole around the pipe, and shall be not less than 1-1/2" or more than 2-1/2" larger than the diameter of the pipes. All plates shall be securely held in place.

## **2.03 UNIONS**

- A. Piping 2-1/2" and larger shall be provided with bolted flange union connections. Weld flanges and bolting shall conform to ANSI B16.5. Bronze flanges shall conform to ANSI B16.24. Flange class shall be as specified in the applicable Sections of the Specifications.
- B. Malleable iron grooved joint unions with brass to iron seats, Class 125, 250, or 300, as required by the application and compatibility requirements with the piping system fitting classification, conforming to MSS SP-77 and ANSI B16.39, shall be provided in piping systems 2" and smaller. Copper unions conforming to ANSI B16.22 shall be provided in copper piping systems. Union connections shall be installed at all coils, control valves, equipment connections, and at other locations shown on the drawings, and required for proper system operation and maintenance.

## 2.04 DIELECTRIC FITTINGS

- A. Dielectric insulating fittings shall be provided to connect dissimilar metals, such as copper tubing to ferrous metal pipe. Connections 2" and smaller shall be threaded dielectric union conforming to ANSI B16.39. Connections 2-1/2" and larger shall be flange union with dielectric gasket and bolt sleeves, conforming to ANSI B16.42. Insulating fittings will not be required between bronze valves and copper piping, unless otherwise specified.

## 2.05 PIPE HANGERS AND SUPPORTS

- A. All piping shall be rigidly supported from the building structure by means of hanger assemblies properly selected and sized for the application in accordance with the manufacturer's recommendations and specifications. Pipe hangers shall be Grinnell, B-Line, Erico, or equivalent.
- B. No attempt has been made to show all required piping supports in all locations, either on the drawings or in the details. The absence of pipe supports and details on any drawing shall not relieve the Contractor of the responsibility for furnishing and installing proper hangers and supports throughout.
- C. Piping hangers shall be spaced on the scheduled maximum spacing and shall have hangers not more than one foot from each elbow and other changes in direction or elevation. Provide additional hangers and supports at valves, strainers, in-line pumps adjacent to flexible connections, and other required heavy components. Piping system shall be installed in an approved manner and shall not overload the building structural frame. Contractor shall provide additional hangers and miscellaneous steel supports as may be required to distribute the piping system load over multiple structural members where required or directed. Maximum allowable spacing for steel and copper piping, other than fire protection piping, shall be as scheduled in Table No. 1.

TABLE NO. 1  
MAXIMUM SUPPORT SPACING FOR STEEL  
AND COPPER PIPING SYSTEMS

<u>Steel Piping</u>	<u>- Maximum Spacing</u>
1/2"	- 5'-0"
3/4" and 1"	- 6'-0"
1-1/4" through 2"	- 8'-0"
2-1/2" through 6"	- 10'-0"
8" through 12"	- 12'-0"
<u>Copper Piping</u>	<u>- Maximum Spacing</u>
1/2"	- 5'-0"
3/4" through 2"	- 6'-0"
2-1/2" through 4"	- 8'-0"
5" and larger	- 10'-0"

- D. Round rods supporting the pipe hangers shall be of the minimum dimensions as scheduled in Table No. 2. Hanger rods shall be hot-rolled steel, ASTM A-36 or A575, galvanized, all-thread. Provide for controlling level and slope by turnbuckles or other approved means of adjustment and incorporate locknuts.

TABLE NO. 2  
HANGER ROD SIZE FOR PIPE HANGER SUPPORTS

1/2" to 2" pipe	- 3/8" rod
2-1/2" to 3" pipe	- 1/2" rod
4" to 5" pipe	- 5/8" rod
6" pipe	- 3/4" rod
8" to 12" pipe	- 7/8" rod

- E. Cast iron soil, waste and vent piping shall be provided with steel clevis type hangers. Grinnell Fig. 590 at each pipe joint and at each fitting.
- F. Hanger spacing for plastic piping system support shall be as scheduled below in Table No. 3 for PVC and CPVC piping, based on pipe full of liquid with specific gravity of 1.0. Piping may be continuously supported with a "V" or "U" shaped support made of metal or heat resistant approved plastic material. Hanger supports shall be in accordance with piping system manufacturer's recommendations.

TABLE NO. 3A  
MAXIMUM SUPPORT SPACING FOR PVC AND CPVC PIPING SYSTEMS  
SCHEDULE 40 PVC - MAXIMUM SPACING  
OPERATING TEMPERATURE (DEGREE F)

Size	PVC AND CPVC				CPVC			
	60 & less	80	100	120	140	160	180	200
1/2" and 3/4"	5.5	5	4.5	4	3	3	3	2.5
1" and 1-1/4"	6	5.5	5.5	4.5	3.5	4	3.5	3
1-1/2" and 2"	6	6	5.5	4.5	3.5	4.5	4	3.5
2-1/2" and 3"	7.5	7	6.5	5.5	4.5	5.5	5	4
4"	8	7.5	7	6	4.5	6	5.5	4.5
5" and 6"	8.5	8	7.5	6.5	5	7	6	5
8"	9.5	9	8.5	7	5.5	7.5	6.5	5.5
10"	10	9	8.5	7	5.5	--	--	--
12"	10.5	10	9	8	6	--	--	--

TABLE NO. 3B  
MAXIMUM SUPPORT SPACING FOR PVC AND CPVC PIPING SYSTEMS  
SCHEDULE 80 PVC - MAXIMUM SPACING  
OPERATING TEMPERATURE (DEGREE F)

Size	PVC AND CPVC				CPVC			
	60 & less	80	100	120	140	160	180	200
1/2"	6	6	5.5	4.5	3.5	3	2.5	2
3/4"	6.5	6	5.5	5	3.5	3	2.5	2
1" and 1-1/4"	7	6.5	6	5	4	3.5	2	2.5
1-1/2" and 2"	7.5	7	6.5	5.5	4	4	3.5	3
2-1/2" and 3"	8.5	8	7.5	6.5	5	4.5	4	3
4"	9.5	9	8.5	7	5.5	5.5	5	3.5
5" and 6"	10	9	8.5	7	5.5	6	5.5	4
8"	11.5	11	10	8.5	6.5	6.5	6	4.5
10"	12.5	12	11	9.5	7	--	--	--
12"	13.5	13	12	10	8	--	--	--

- G. Fire protection system shall be supported in strict accordance with the requirements contained in the applicable NFPA pamphlets and as specified in Division 21, Fire Suppression Systems.
- H. Hangers, clamps and other support materials in contact with copper piping shall be copper or copper plated to prevent electrolysis. Hangers for copper piping shall be copper plated adjustable ring type Grinnell Fig. CT-269, adjustable swivel ring, Grinnell Fig. CT69, Fig. CT-65 or adjustable clevis type or equivalent. Provide minimum 10 mil plastic wrap around copper pipe at any ferrous point of attachment including trapeze hangers, clamps, and other supports.
- I. Hangers for steel shall be steel clevis type hangers, Grinnell Fig. 260 or equivalent.
- J. Where piping is installed side by side, the Contractor may support the piping utilizing trapeze type hanger assemblies. Horizontal trapeze member shall be galvanized steel channel, not less than 1-1/2" x 1-1/2" x 12" gauge, or Unistrut. Contractor shall provide heavier steel members as required for the load to be supported and the distance span. Trapeze hangers shall not be utilized for fire and sprinkler piping and plumbing drain waste and vent piping. Hanger rods shall be as specified above, properly sized for the load supported but not less than 5/8" diameter. Un-insulated copper piping shall be isolated from the steel trapeze. Individual pipe shall be guided on the horizontal member at every other hanger point with 1/4" U-bolt fabricated from steel rod. Provide full circle galvanized sheetmetal insulation shield for insulated piping at trapeze hangers with U-bolt guide and galvanized sheetmetal insulation half-shield at other trapeze hangers. Insulation shield shall be 18 gauge minimum, Grinnell Fig. 167 or equivalent.

- K. Where shown on the drawings and as required for the proper control of the system expansion and contraction, and for heating hot water provide rolled type supports. Roller hangers shall be Grinnell Fig. 181 or equivalent and roll support for trapeze hangers and pipe racks shall be Grinnell Fig. 271, Erico, or equivalent complete with base plate.
- L. Special piping supports including tunnel support racks, wall support racks, floor mounting pedestal type supports shall be provided as indicated on the drawings, and as required for the proper support for the piping systems.
- M. Vertical piping shall be supported at each floor level by means of riser clamps, Grinnell Fig. 261 and Fig. G-121, Erico, copper clad for copper piping systems, or equivalent. Proper allowance for the expansion and contraction of the vertical risers shall be provided. Contractor shall submit shop drawings indicating proposed method for support and control of expansion and contraction of vertical piping. See Section 23 0505 for expansion joints, expansion compensators, pipe guide and pipe anchors.
- N. The use of pipe hooks, chains, or perforated iron for pipe hanger supports will not be permitted.
- O. All insulated piping systems specified in Section 22 0700, Plumbing Insulation and Section 23 0700, HVAC Insulation, shall be provided with individual hangers sized to encircle the insulation. Hangers for insulated domestic water piping and roof drain piping systems may be installed under the insulation. See applicable sections for insulation thickness requirements. The specified piping systems where supported by means of trapeze hangers shall not rest directly on the trapeze horizontal members. The insulation at hangers and trapeze hangers shall be protected by means of insulation shield, Grinnell Fig. 167, Erico, or equivalent. Grinnell Fig. 160, Erico, or equivalent, curved steel pipe saddle, shall be provided at roll hangers. Contractor shall provide section of high density calcium silicate insulation or thermal hanger shields as manufactured by Pipe Shields, Inc., or equivalent, at all insulation piping system hanger and support points for piping 1-1/2" or larger.
- P. Attachment of piping hangers to the building structure shall be provided in a manner approved by the Architect. The Contractor shall provide concrete inserts in the building construction at the time the concrete is poured and hangers shall be attached to these inserts. Self-drilling expansion anchors, Federal Specification FF-S-325, may be used in concrete construction not less than 4" thick. Applied load shall not exceed manufacturer's approved ratings. Power driven fasteners may be used in existing concrete or masonry not less than 4" thick where approved by the Architect. Attachment to steel construction shall be by means of beam clamps Grinnell Fig. 131, Erico, C-clamps Grinnell Fig. 86, Erico, or equivalent may be utilized for attachment of light loads as approved by the Structural Engineer. Attachment to wood construction shall be by means of wood screws or lag bolts.

## **2.06 PIPE SLEEVES**

- A. Pipe sleeves in concrete and masonry construction, footings and beams shall be Schedule 40 black steel pipe through 10", standard wall thickness for sizes 12" and larger, ASTM A 53, A 106, or A 120.
  - 1. For sleeve installation below grade in cast in place concrete wall or floor and masonry construction, sleeves shall be GPT type WS sleeves with minimum 2" water-stop collar or equivalent. The sleeves shall be provided free of welding slag. The water stop collar shall be welded all around on both sides to the sleeve at the point on the sleeve that positions it at the midpoint of the wall. Sleeve shall be primed inside and outside with Sherwin Williams Water Base Red Primer, or approved equivalent.



- B. Pipe sleeves in gypsum board construction shall be galvanized steel metal, minimum 24 gauge; round tube closed with welded longitudinal joint and flanges on both sides.
- C. Pipe sleeves shall be furnished and set by the Contractor and they shall be responsible for their proper and permanent location. Piping will not be permitted to pass through footings, beams or ribs except with written consent of the Architect.
- D. Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through gypsum board stud walls, concrete, and masonry construction and at all fire and smoke rated walls and partitions.
- E. Where insulated piping is installed, calcium silicate inserts to match the insulation thickness and extending 1" past the sleeve on both ends, shall be provided.
- F. Sleeves shall be not less than 1" or more than 2" larger in diameter than the pipe to be installed.
- G. Pipe sleeves in floors shall extend 2" above finished floor in chases and equipment room areas unless otherwise approved by the Architect. Openings between piping and sleeves shall be made watertight with plastic cement installed to a minimum depth of 2".
- H. Un-insulated piping passing through fire walls, smoke wall, sound control walls and air plenum separations shall be sealed airtight to the adjacent construction by means of UL approved fire stop sealant materials.
- I. Insulated piping passing through fire walls and smoke walls shall be provided with Calcium Silicate pre-formed pipe insulation of thickness to match adjacent piping, extending minimum 1-inch beyond sleeve in each direction.
  - 1. For penetrations through concrete or masonry walls/floors, the space between the piping sleeve and insulation shall be sealed airtight with UL approved firestop sealant and packed with minimum 4" thickness mineral wool (minimum 4 pcf density) tightly packed and recessed to accommodate sealant.
  - 2. For penetrations through gypsum board wall construction, both sides of the annular space between the insulation and sleeve shall be sealed with UL approved firestop sealant.
- J. Penetrations of gypsum board sound walls and air plenum separators shall be caulked airtight with an approved UL firestop sealant.

## **2.07 PIPE SLEEVE SEAL SYSTEMS**

- A. Provide pipe sleeve seal systems by one of the following:
  - 1. Link-Seal Modular Wall Penetration Seal as manufactured by GPT.
  - 2. Metraflex Company
  - 3. Proco Products, Inc.
- B. Description: Modular sealing element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Plastic, reinforced nylon polymer
  - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements.
- C. Pipe sleeve seal system shall be utilized at all exterior wall penetrations.

- D. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### **PART 3 EXECUTION**

#### **3.01 PIPING INSTALLATION**

- A. Provide and erect, according to the best practices of the trade, all piping shown on drawings and required for the complete installation of these systems. The piping shown on the drawings shall be considered as diagrammatic for clearness in indicating the general run and connections, and may or may not in all parts be shown in its true position. The piping may have to be offset, lowered or raised as required or as directed at the site. This does not relieve the Contractor from responsibility for the proper erection of systems or piping in every respect suitable for the work intended as described in the specifications. In the erection of all piping, it shall be properly supported and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging. All piping shall be arranged so as not to interfere with removal and maintenance of equipment or filters or devices; and so as not to block access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment including refrigeration machines. All piping shall be so installed to ensure noiseless circulation. All valves and specialties shall be so placed to permit easy operation and access, and all valves shall be regulated, packed and adjusted at the completion of the work before final acceptance. All piping shall be erected to ensure proper draining.

#### **3.02 JOINTS**

- A. Caulked Joints: Caulked joints in hub-and-spigot piping and vent piping shall be packed firmly with white oakum, "Sealite No. 110," or hemp and caulked with pure molten lead not less than 1" deep. Resilient molded gasket joints or "Ty-Seal" may be used in lieu of lead and oakum for sanitary soil, waste and vent piping. No-hub pipe and fittings will be accepted with the exception that no-hub pipe and fittings shall not be allowed for buried installation.
- B. Screwed Joints: Shall have American Taper pipe threads. Ream pipe ends and remove burrs after threading. Make up joints using Teflon tape or other approved compound applied to the male threads only.
- C. Solder Joints: Copper tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings shall be made with a non-corrosive paste flux and solid 95-5 tin-antimony wire solder, unless otherwise specified. Cored solder will not be permitted. 50/50 lead solder shall not be permitted for any applications.

- D. Welded Joints: On black steel piping 2-1/2" and above in size, the joints may be welded. Welding shall be done using either gas or electric welding equipment. Certified welders shall be used. Welders shall be certified in accordance with Section IX of ASME Boiler and Pressure Vessel Code, latest edition. All pipe surfaces shall be thoroughly cleaned before welding. Each joint shall be beveled before being welded. Piping shall be securely aligned and spaced, and the width of circumferential welds shall form a gradual increase in thickness from the outside surface to the center of the weld. All fittings used in the welded piping systems shall be standard ASA fittings, and shall be of standard pipe thickness. The Contractor shall provide a fireproof mat or blanket to protect the structure and adequate fire protection at all locations where welding is done. The use of fittings formed from welded pipe sections will not be permitted.
- E. Flanged Joints: Flanged joints shall conform to the American Standard for cast iron flanged pipe fittings, Class 125, 150 or 300 as specified in the applicable Sections of these specifications. Gaskets shall be full face or ring type, non-asbestos, suitable for the service on which used.

### **3.03 PUMP AND EQUIPMENT CONNECTIONS**

- A. All piping connecting to pumps and other equipment whether connected utilizing flexible connectors or with solid pipe connectors, shall be installed without strain at the pipe connection of the equipment. The Contractor shall be required, if so directed, to disconnect piping to demonstrate that piping has been so connected.

### **3.04 EXPANSION AND CONTRACTION**

- A. The Contractor shall make all necessary provisions for expansion and contraction of piping with offsets or loops and anchors as required to prevent undue strain. Contractor shall provide shop drawings for proposed method and arrangement for control of expansion and contraction of piping. See Section 23 0505 for expansion joints, expansion compensators, pipe guides and pipe anchors.

### **3.05 PROTECTIVE COATINGS**

- A. All underground steel pipe shall be wrapped with "Scotchwrap" No. 50 tape or equivalent, to give not less than two complete layers on the entire underground piping system, or piping shall have X-Tru-Coat factory applied plastic protective covering.

### **3.06 FLUSHING, DRAINING AND CLEANING PIPE SYSTEMS**

- A. The Contractor shall flush out all water systems with water before placing them in operation. Other systems shall be cleaned by blowing them out with compressed air or nitrogen. After systems are in operation and during the test period, all strainer screens shall be removed and thoroughly cleaned.

### **3.07 TESTING**

- A. Before any insulation is installed or before piping is covered or enclosed, all piping systems shall be tested and proven tight at not less than 150% of the maximum service pressure which the piping systems will be required to handle. Piping system tests shall be as specified in the applicable sections of this Specification. All tests shall be witnessed and approved by the Architect.
- B. All labor, material, and equipment required for testing shall be furnished by the Contractor. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying the tests. To perform tests, all lines shall be flushed and cleaned.

- C. All safety measures required by codes or ordinances or reasonably applicable to the situation shall be provided by the Contractor in conjunction with the testing of the piping systems.
- D. Equipment or piping to be pressure tested shall not be insulated, covered, or concealed prior to that test. Underground piping may be partially backfilled prior to pressure test when required for application of the test except that joints shall remain exposed until after the test. Tie rods, clamps etc., shall be in place and fastened.
- E. Tests shall not be used to establish pressure ratings.
- F. Protect all piping and equipment against over pressure, collapse from vacuum, and hydraulic shock during the filling, testing and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating.
- G. Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60°F. Note that some applicable codes may require testing above a specified minimum temperature.
- H. Remove from the system all pumps, turbines, traps, expansion joints, instruments, control valves, safety valves, rupture discs, orifice plates, etc., which might be damaged by the test. Also remove all items such as orifice plates which might trap air in a system to be hydrostatically tested. Disconnect all instruments and air lines where copper tubing starts.
- I. Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.
- J. During hydrostatic testing of lines, provide temporary supports to prevent overstressing supports or hangers. When tests are completed, remove all temporary supports, locks, stops, etc., and adjust supports for their cold load and alignment.

**END OF SECTION**

## **SECTION 23 05 05 PIPING SPECIALTIES**

### **PART 1 GENERAL**

#### **1.01 REQUIREMENTS**

- A. Furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform to applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.
- B. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.
  - 1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
  - 2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

#### **1.02 RELATED SECTIONS**

- A. Section 23 05 00, Common Work Requirements.
- B. Section 23 05 04, Pipe and Pipe Fittings.
- C. Section 23 05 23, Valves.

#### **1.03 SUBMITTAL DATA**

- A. Furnish complete submittal data for all piping specialties including manufacturer's specifications, performance characteristics, ratings, installation instructions, certifications and approval of listing agencies, wiring diagrams, and selection analysis.

### **PART 2 PRODUCTS**

#### **2.01 STRAINERS**

- A. Strainers suitable for the application shall be furnished and installed on the high pressure side of pressure reducing valves, pressure regulating valves, suction side of pumps, inlet of indicating and control instruments and equipment subject to sediment damage, and as shown on the drawings. Strainers shall be "Y"-type unless basket strainers are indicated. Tee-type strainers will not be accepted. Strainer element shall be removable without disconnecting piping. Screens shall be Type 304 stainless steel with 1/8 inch perforations for water service, and 1/16 inch perforations for gas services. Every strainer shall be provided with a blow-off connection not less than 1/2" NPT and provided with a ball valve the full size of the strainer outlet tapping. Strainers located outside of mechanical equipment rooms and above ceilings shall be provided with hose connection and cap on the outlet of the blowoff valve. Strainers shall be Spirax Sarco, Armstrong, Febco, Grinnell, Hoffman, Keckley, Metraflex, Mueller, Yarway, or equivalent.
- B. Strainers 2" and under for copper piping systems shall be threaded connection, bronze body, 250 PSIG maximum working pressure, suitable for steam, oil, gas and liquid service, Sarco BT or equivalent.
- C. Strainers 2" and under for steel piping systems shall be threaded connection, bronze body, as specified above or cast iron body as specified herein, except all strainers in galvanized steel domestic water systems shall be bronze body. Cast iron strainers shall be threaded connection, 250 PSIG maximum working pressure, suitable for steam, oil, gas and liquid service, Sarco IT or equivalent.

- D. Strainers 2-1/2 inches or larger shall be standard flanged connection ANSI-125, cast iron body, suitable for steam, oil , gas, and liquid service, 125 maximum working pressure at 353° F maximum temperature, Sarco CI-125 , or equivalent.
- E. Basket strainers 2" and larger shall be standard flanged ANSI-125, cast iron body bolted cover, Type 304 stainless steel screen, suitable for steam or liquid service, 125 maximum working pressure at 353°F maximum temperature, Sarco 528-B-125, or equivalent.

**2.02 SUCTION DIFFUSERS**

- A. Suction diffusers shall be furnished and installed at the suction of pumps where indicated on the drawings. Suction diffuser outlet shall be not less than pump suction size and suction diffuser system inlet shall be a minimum of one size larger than suction diffuser outlet size. Suction diffuser shall provide for a smooth flow of water into the pump inlet, and shall be complete with strainer, adjustable support leg, and start-up strainer. Start-up strainer shall be removed at the final testing and balancing phase.

**2.03 PRESSURE GAUGES**

- A. 2.5-inch glycerin filled, SS case, 1.5% accuracy, dual scale (PSI & KPA), bronze bourdon tube and 0.25-inch NPT connection, brass snubber with properly selected filter disc for the application, and needle valve with knurled brass or ABS plastic handle. Provide multiple needle valves where a single pressure gauge is used to measure pressure at multiple points. Provide siphon for steam gauges. Winters, Weiss, Marshalltown, Ashcroft, Terice, Weksler, or equivalent.
- B. Select pressure range as indicated on the drawings, or if not indicated select so that the normal operating pressure is approximately 50% of the scale range. Provide compound and vacuum gauges where required by the application.
- C. Install gauges so they are easily readable from normal operator level. Where the sensing location is not convenient to the operator, install the gauge and needle valves at a location easily read from normal operator level, extend piping from there to the sensing point on the main pipe, and provide a ball valve for isolation at the main. In addition, provide drain and vent valves to facilitate removing air and water from the sensing line.

**2.04 THERMOMETER AND THERMOMETER WELLS**

- A. Either liquid filled or digital type, vari-angle, 3-1/2" stem for pipe sizes through 6" and 6" stem for pipe sizes 8" and larger, dual scale (degrees F & C), separable brass socket, extension neck where installed in insulated piping, and accuracy 1% of range. Winters, Weiss, Moeller, Terice, Weksler, Duro, or equivalent.
  - 1. Liquid Filled Type: 9" case, straight form, V-shaped, high pressure die cast aluminum, baked enamel finish, with heavy glass-protected front firmly secured with spring action, and organic liquid filled magnifying lens. Winters 9IT or approved equal.
  - 2. Digital Type: May be used both indoors or in outdoor locations not exposed to sunlight, high impact ABS plastic housing, suitable for operation at 16 Lux. Winters 9IT or approved equal.
- B. Ranges: Provide the following ranges except where otherwise indicated:
 

Heating Water	30-240 degrees F
Chilled Water, Condenser Water, Domestic Cold Water	0-120 degrees F
Domestic Hot Water	30-180 degrees F

## **2.05 MANUAL AIR VENTS**

- A. Provide manual air vents at locations indicated on the drawings, at the high point of all liquid piping system and as otherwise required for proper air elimination and liquid circulation.
- B. Manual air vents shall be 1/2" brass ball valves as specified in Section 23 05 23. Provide brass hose connection and plug on valve outlet.

## **2.06 AUTOMATIC AIR VENT**

- A. Provide automatic air vents for all separators, at the high point of all hydronic systems and at locations indicated on the drawings. Automatic air vents shall be 3/4" size, minimum. Provide manual shut-off ball valve between automatic air vent and piping system. Automatic air vents shall be float type, 150 PSIG maximum working pressure, 3/4" NPT system connection, Amtrol Model No. 720, Taco, Armstrong, Watson-McDaniel, Hofmann, or equivalent.

## **2.07 MANUAL DRAIN VALVES**

- A. Provide manual drain valves at locations indicated on the drawings, at the low points of all liquid piping systems, and as otherwise required for proper draining of systems. Manual drain valves shall be sized as shown on the drawings but not less than 3/4" size, brass ball valve, as specified in Section 23 0523. Pipe discharge from drain valves to floor drain, floor sink, or as otherwise directed for indirect discharge into sanitary sewer system. For drain valves located above ceiling or in location outside mechanical equipment areas provide brass hose connection and cap for valve discharge.

## **2.08 TEMPERATURE AND PRESSURE TEST PLUGS**

- A. 0.25 or 0.5-inch NPT with brass body, EPDM core, and brass gasketed cap. Winters, Peterson, or approved equal. Supply one pressure/temperature test kit with two 4" Duro #105 pressure gauges of 1% accuracy and ranges as required by application; and two 2" Tel-Tru #39R Bi-metal thermometers with 8" stem, 1% accuracy, and ranges as required by the applications; and a protective carrying case.

## **2.09 FLOW BALANCE VALVE**

- A. Furnish and install calibrated balance valve equivalent to Bell and Gossett "circuit-setter," Griswold, Taco, Armstrong, or equivalent at locations indicated on the drawings. Balance valves shall be brass or cast iron body, NPT or sweat connections through 3" size and flanged connections above 4" size, 125 PSIG working pressure minimum. Balance valve shall be equipped with two brass readout valves with integral EPT insert and check valve designed to minimize system fluid loss during balancing and monitoring process. Each valve shall be provided with a calibrated nameplate permitting accurate system balance. Flow balance valves shall be not less than full line size with maximum pressure drop of 10 feet. Provide one readout kit including flow meter, readout probes, hoses, flow charts and calculators, all contained in carrying case.

## **2.10 WATER FLOW MEASURING DEVICES**

- A. Furnish and install cast iron wafer type flow meter equivalent to Bell & Gossett "OP-Series," Griswold, Taco, Armstrong, or equivalent at locations indicated in the drawings. Flow meters shall be equipped with two brass readout valves with integral EPT insert and check valve designed to minimize system fluid loss during monitoring process. Flow meter shall be furnished with a calibrated nameplate specifying the flow range through a range of differential pressures. Water flow measuring devices shall be not less than full line size with maximum pressure drop of 10 feet. Readout kit furnished with Flow Balance valves specified above shall be compatible and utilized for flow meters specified herein also.

## **2.11 AUTOMATIC FLOW LIMITING VALVES**

- A. To maintain constant flow within 5 percent over a range of 2-32 psid. Bronze or cast iron body, stainless steel cartridges, two pressure readout ports with quick disconnect valves and caps, SS identification tag marked with rated flow. Valves through 2 inch size shall be threaded connection, valves over 2 inches shall be wafer type; 150 psig rated. Supply one readout kit including flow meter, hoses and flow charts all contained in carrying case. Size valves for required flows. Griswold, FDI, or approved equal.

## **2.12 FLEXIBLE CONNECTORS**

- A. Furnish and install flexible connectors at locations indicated on the drawings and at all piping connections associated with equipment mounted on or hung from vibration isolators. Flexible connectors shall be constructed of multiple ply nylon cord fabric and neoprene, operating pressure 150 PSIG at 220°F through 12" size and operating pressure of 125 PSIG at 220°F for sizes 14" through 24". Provide butyl or Hypolon liner and applications with fluid temperatures in excess of 225°F.
- B. Flexible connectors shall be single or twin sphere with Class 150 flange connections for sizes 2-1/2" and larger and threaded connections with galvanized female unions for sizes 3/4" through 2". Mason Industries MFTCR, Hyspan, Metra-Flex, Keflex, Proco, or equivalent. Flexible connectors required for outdoor installation shall be braided stainless steel type.
- C. Installation of flexible connectors shall be in strict accordance with manufacturer's recommendations. Spacing between piping system flanges shall be based on the flexible connector's expanded length corresponding to the system's operating pressure. Control rods or cables shall be provided for units installed in unanchored applications where system operating pressure and dynamic forces exceeds manufacturer's recommendations for unrestrained installations.

## **2.13 EXPANSION TANK**

- A. Furnish and install diaphragm type, pre-pressurized, ASME code construction 125 PSIG working pressure, expansion tank in horizontal or vertical arrangement as shown on the drawing and required for equipment space allocation. Properly sized expansion tanks shall be provided for all closed circuit hydronic systems. Connect expansion tank to the low pressure side of the piping system with 3/4" minimum line size; provide quarter turn ball valve with handle removed for manual isolation valve. Contractor shall field verify expansion tank air charge and re-charge as required to maintain correct system pressurization and tank expansion volume. Expansion tanks shall be Amtrol, Woods, Armstrong, Taco, or equivalent.

## **2.14 AIR SEPARATOR**

- A. Furnish and install air separator, inline or tangential type as shown on the drawings for all closed circuit hydronic system. Inline air separators shall be fabricated of steel or cast iron, 125 PSIG working pressure. Tangential type air separators shall be ASME code construction for 125 PSIG working pressure and shall be furnished with internal perforated stainless steel air collection tube, bottom blow down connection and removable stainless steel strainer element with 3/16" perforations and free area of not less than five times the cross-sectional area of the connecting piping.
- B. Each air separator shall be provided with an automatic air vent, 3/4" size, Amtrol Model No. 720 or equivalent, with manual shut-off ball valve between automatic air vent and air separator.
- C. Air separators shall be full line size and installed at the high point of the piping system unless otherwise indicated in the drawings.
- D. Air separators shall be Amtrol, Woods, Armstrong, Taco, or equivalent.



## **2.15 WATER PRESSURE REGULATING VALVES**

- A. Furnish and install water pressure regulating valves, Watts U5B, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent, 3/4" size minimum for water makeup to all hydronic systems and at other locations as shown on the drawings. Water pressure regulating valves shall be brass body, union inlet with integral strainers, 300 PSIG maximum working pressure, with built-in thermal expansion bypass.
- B. For high water capacity applications provide Watts 2235B, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent.
- C. Provide high or low pressure range depending on application requirements. Set pressure shall be as shown on the drawings, or as required to provide a minimum system pressurization of 12 PSIG at the system's highest point for closed circuit hydronic systems, or as recommended by equipment manufacturers.

## **2.16 WATER PRESSURE RELIEF VALVES**

- A. Furnish and install ASME labeled, National Board Stamped, water pressure relief valves, Watts Series 174A or 740, Bell & Gossett, Amtrol, Cash, Jordan, or equivalent, 3/4" size minimum for relief of all water makeup to all closed circuit hydronic systems. Properly sized relief valves shall be provided where required for over-pressure protection on heat exchangers, converters, boiler, and pressure vessels, and other locations as shown in the drawings.
- B. Relief valves shall be sized for the full system heating capacity, to match the makeup capacity, or as otherwise required to protect the system from over-pressure conditions. Relief valves shall be factory pre-set for maximum pressure rating shown in the drawings, or for approximately 125% of the system operating pressure, but in no case shall the relief valve setting exceed the maximum safe operating pressure of the system and system components and equipment.

## **2.17 WATER TEMPERATURE AND PRESSURE RELIEF VALVES**

- A. Furnish and install ASME labeled, National Board stamped water temperature and pressure relief valves, Watts, Cash, or equivalent, for all domestic water heaters, domestic water storage tanks, and other locations indicated in the drawings.
- B. Water temperature and pressure relief valves shall be sized for the full system heating capacity at 210°F maximum operating temperature and shall be furnished with the required valve thermostat tube extension length.

## **2.18 WATER REDUCED PRESSURE BACKFLOW PREVENTERS**

- A. Furnish and install water reduced pressure backflow preventer, as approved and accepted by the City of Colorado Springs, State of Colorado, Febco Model 825Y, Hersey, Beeco, Watts, or equivalent. 3/4" minimum size shall be provided for water makeup to all required HVAC systems. Backflow preventers shall be provided at other locations as shown on the drawings. Reduced pressure backflow preventer shall include two shut-off gate or ball valves, two check valves, pressure relief valve, and four test cocks. Units shall be factory assembled, tested and certified. Units 2" and smaller shall be brass body, threaded connections, 175 PSIG maximum working pressure. Units 2-1/2" and larger shall be provided with flanged connections.
- B. Water reduced pressure backflow preventer installation shall be in accordance with manufacturer's instructions and City of Colorado Springs, State of Colorado requirements for access for testing and inspection.
- C. See Division 22 for backflow protection associated with building domestic water supply system.
- D. See Division 21 for backflow protection associated with building fire protection system.

- E. Backflow protection devices associated with landscaping and irrigation systems shall be furnished and installed under the Site Work sections of these specifications.

## **2.19 CHEMICAL WATER TREATMENT**

- A. Chemical water treatment for hydronic systems shall consist of equipment, start-up, testing, chemicals and one-year full service as listed on the Equipment Schedule, shown on the Drawings, and specified under the applicable piping system sections of this Specification.
- B. Chemical water treatment equipment and chemicals for hydronic systems will be furnished and installed by the Owner. Provide all connections to systems required for new chemical treatment piping and accessories required for the chemical treatment equipment, as shown on the Drawings and as directed by the Owner's Representative.

## **2.20 FLOW METERS AND INSTRUMENTATION**

- A. Water meters and instrumentation shall be furnished and installed as shown on the drawings and specified in Section 23 09 00.

## **2.21 SOLENOID VALVES**

- A. Furnish and install electric solenoid valves as shown on the drawing and as required for the operation of the mechanical systems. Solenoid valves shall be 115 volt single phase, 60 Hz, two-way arrangement, two positions with normally open or normally closed arrangement as required of the application. Solenoid valves associated with safety protection of systems including freeze-protection, drain down, etc. shall be provided such that in the event of a power failure the system shall fail to a safe operating condition. Solenoid valves shall be as manufactured by ASCO, Armstrong, Honeywell, Metrex, or equivalent.
- B. See Section 23 0500, Common Work Requirements, and Section 23 0549, HVAC and Electrical Installation Coordination, for requirements associated with electrical control and power wiring for solenoid valves. Furnish hazardous duty enclosure where required by the application.

## **2.22 FLOW SWITCHES**

- A. Furnish and install flow switches where required for protection and/or monitoring of mechanical equipment including water chillers, boilers, pumps, etc. and as otherwise shown on the equipment schedule, and the drawings.
- B. Flow switches shall be either paddle type or differential pressure type as required by the application and as shown on the drawings, except differential pressure type flow switches shall be utilized for water chillers and other applications where minor pressure fluctuation could cause nuisance tripping of equipment operation.
  - 1. Paddle type flow switch shall be McDonnell and Miller Model FS7-4 Series, or equivalent designed for industrial duty, brass body and trim, 300 PSIG maximum working pressure, paddle size as required for application, single pole double throw switches, with electrical rating of 7.4 full load amps at 115 VAC. Provide hazardous duty enclosure where required by the application. Flow switches shall be installed in a horizontal pipe with inlet and outlet conditions necessary to provide trouble-free operation.
  - 2. Differential pressure flow switch shall be Honeywell Model 406 Series or equivalent, adjustable pressure differential setting, dustproof mercury switch enclosure, 1/4" NPT bellows connections, single pole, single throw switch, with electrical rating of 7.2 full load amps at 115 vac. Differential pressure switches shall be properly supported on the equipment controlled or wall mounted adjacent to the equipment or piping system.

## **2.23 EXPANSION JOINTS**

- A. Furnish and install corrugated bellows expansion joint, Hyspan Series 1500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, self-equalizing, 150 PSIG working pressure at 850°F, Class 150 ASA flange connections 1-1/2" size and above, single or dual center base configuration as shown on the drawings, constructed of corrugated Type 304 or 321 stainless steel, ring controlled, with integral stainless steel or Monel sleeve, and removable carbon steel external housing to protect bellows and support insulation. Furnish limit rods to prevent expansion joint from exceeding rated travel. Joint design shall be for maximum flexibility over 10,000 cycles minimum.
- B. Expansion joint sizing and installation shall be as shown on the drawing and as recommended by the manufacturer.
- C. Expansion joints shall be insulated with flexible 2" minimum thickness of high temperature fiberglass blanket insulation furnished with joint and installed under the external protective housing.
- D. Contractor shall carefully check expansion joint limit rods and make adjustments as required to ensure proper joint movement and operation.

## **2.24 EXPANSION COMPENSATORS**

- A. Furnish and install expansion compensators, Hyspan series 8500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, stainless steel laminated bellows with stainless steel or carbon steel shroud, 175 PSIG pressure rating at 250°F, 2 inch straight line expansion and 1/2 inch contraction. Furnish copper tube with sweat ends for compensators installed in copper piping systems. Furnish standard wall carbon steel pipe tube for compensators installed in steel piping systems, threaded connectors for sizes 2" and smaller and Class 150 ASA flange connection for sizes 2-1/2" or larger.
- B. Expansion compensators sizing and installation shall be as shown on the drawings and as recommended by the manufacturer.

## **2.25 PIPE ALIGNMENT GUIDES**

- A. Furnish and install factory fabricated steel pipe alignment guides, Hyspan Series 9500, Metra-Flex, Keflex, Proco, Flexonics, or equivalent, to maintain the longitudinal position of pipe centerline between expansion joints and compensators with axial restraint. Alignment guides shall consist of a bolted two-section outer cylinder and base with two-section guiding spider bolted tight to the pipe guide. Guide and spider shall be sized to clear pipe and pipe insulation and long enough to prevent over travel of spider and cylinder. Guides shall not be used for pipe support.
- B. Alignment guides shall be arranged and installed as shown on the drawings and as recommended by the manufacturer.

## **2.26 PIPE ANCHORS**

- A. Pipe anchors shall be constructed of welded steel as detailed on the drawings.
- B. Pipe anchors shall be arranged as shown on the drawings and as required to properly control/piping system expansion and contraction in conjunction with system flexibility due to off-sets, bends, and loops and expansion joints and compensators.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. All specialties shall be installed in accordance with the best standard practices and as recommended by the manufacturer.
- B. Install thermometers so they are easily readable from operator level.

- C. Where thermometers, gauges, vents and test fittings occur in insulated piping systems or on insulated equipment, extension necks shall be provided to extend beyond the insulation.

### **3.02 AIR VENTS**

- A. Manual air vents shall be installed as specified herein and at the high points in all piping systems.
- B. Automatic air vents shall be installed as specified herein and at locations indicated on the drawings. Automatic air vents shall be installed level and in accordance with manufacturer's directions to properly vent system, complete with individual isolation valves.

### **3.03 STRAINERS**

- A. All strainer screens, including basket strainers and suction diffusers, shall be removed and cleaned prior to commencing testing and balancing work and shall be maintained clean through project final acceptance by the Owner. Suction diffuser start-up strainers shall be removed prior to final system testing and balancing work.

### **3.04 TEST AND ADJUSTMENT**

- A. Field adjust all water pressure regulating valves, flow switches, water level controls, and specialties to provide required system operation.
- B. Field test and verify the operation of all safety devices including water relief valves and temperature and pressure relief valves.

### **3.05 RELIEF VALVE DISCHARGE**

- A. Water pressure relief valve and water temperature and pressure relief valve discharges shall be piped full size to the outside of the building or discharged indirectly in a properly sized building floor drain or floor sink, and as allowed by the Building Mechanical and Plumbing Codes. When the operating discharge temperature is in excess of 212°F, the discharge shall be equipped with a splash shield or centrifugal separator.
- B. Water reduced pressure backflow preventer discharge shall be piped full size to the outside of the building or discharged indirectly into a properly sized building floor drain or floor sink as allowed by the Building Mechanical and Plumbing Codes. Provide a bronze air gap funnel with stainless steel fasteners for installation under reduced pressure backflow prevention relief valve. Febco Model AGD or equivalent, 1" discharge pipe size for backflow preventer size through 2".

## **END OF SECTION**

## **SECTION 23 05 23**

### **VALVES**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. All Valves shall conform with current applicable provisions of the General Conditions, Supplemental General Conditions, and General Requirements.
- B. All Valves shall meet the current MSS Specifications covering Bronze & Iron Valves. MSS-SP-80, MSS-SP-70, MSS-SP71, MSS-SP-85 where applicable.
- C. Lead Ban: All systems and system components, pipe, fittings, and fixtures delivering water for human consumption shall be lead free.
  - 1. Any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.
  - 2. Lead free refers to <0.25% weighted average lead content in relation to wetted surface of pipe, fittings, and fixtures in systems delivering water for human consumption, and solder and flux which does not contain more than 0.2% lead.

##### **1.02 RELATED SECTIONS**

- A. Section 23 05 00 for Common Work Requirements for HVAC.
- B. Section 23 05 23 for Valve Identification.
- C. Section 23 05 04 for Pipe and Pipe Fittings.
- D. Section 23 23 13 for Refrigerant Piping System.
- E. Section 23 09 00 for Automatic Temperature Control Valves.
- F. Division 21 for fire suppression system valves and tamper switches.
- G. Division 22 for plumbing system.

##### **1.03 SCOPE**

- A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems.

##### **1.04 VALVE REQUIREMENTS**

- A. All Gate, Globe, Check, Ball valves shall be manufactured by Milwaukee, Nibco, Apollo, Stockham, Powell, Crane, Tyco-Grinnell, or equivalent.
- B. All lubricated plug valves shall be as manufactured by Rockwell, Walworth, Homestead, or equivalent.
- C. Butterfly valves shall be as manufactured by Milwaukee, W. C. Norris, Centerline, Crane, Demco, Keystone, Tyco-Grinnell, Victaulic, Nibco, or Dezurik, or equivalent. Butterfly valves may be used for closed circuit chilled water, heating hot water (200°F maximum) run-around coil and heat pump circulating water systems and for condensing water systems. Butterfly valves shall not be used for domestic water or other non-specified service.
- D. Ball valves shall be utilized in lieu of gate valves and globe valves for all HVAC and plumbing systems for sizes 2" and smaller.
- E. Butterfly valves may be substituted for gate, globe and ball valves for specified services, and for other services as may be approved by the Architect.
- F. All valves furnished under Division 22 and 23, of the same type, shall be products of a single manufacturer.

- G. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.
- H. Provide chain operators for valves 4" and larger installed within mechanical equipment spaces where valves center line is in excess of eight feet above the floor or operating platform and as otherwise indicated on the drawings.

## **PART 2 PRODUCTS**

### **2.01 GENERAL SERVICE VALVES, HVAC AND PLUMBING SYSTEMS**

- A. Gate Valves - 2" and Smaller, Class 125: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 125 construction, solid disc, rising stem, gland packed, non-asbestos packing. Milwaukee 148 (Threaded) or equivalent; Milwaukee 149 (Solder), or equivalent.
- B. Gate Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, solid wedge disc, rising stem, union bonnet, gland packed, non-asbestos packing. Milwaukee 1151 (Threaded) or equivalent; Milwaukee 1169 (Solder), or equivalent
- C. Gate Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A-126 Class B cast iron, flanged ends, Class 125 construction, OS & Y Type, rising stem, bronze trim, non-asbestos packing. Milwaukee F2885 or equivalent.
- D. Globe Valves - 2" and Smaller, Class 125: Valves 2-1/2" and smaller shall be of ASTM B-62, Class 125 construction, bronze trim, gland packed, non-asbestos packing. Milwaukee 502 (Threaded), or equivalent; Milwaukee 1502 (Solder) or equivalent.
- E. Globe Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be of ASTM B-62, bronze, Class 150 construction, bronze trim, composition disc, union bonnet, gland packed, non-asbestos packing. Milwaukee 590 (Threaded) or equivalent; Milwaukee 1590 (Solder), or equivalent.
- F. Globe Valves - 2-1/2" and Larger, Class 125: Valves 2-1/2" and Larger shall be of ASTM A-126, Class B cast iron, flanged ends, Class 125 construction, bolted bonnet, gland packed, non-asbestos packing. Milwaukee F2981M or equivalent.
- G. Check Valves - 2" and Smaller, Class 125: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 125 construction, Y-pattern, swing type design, teflon seat, disc for steam service, Buna-N for water service. Milwaukee 509 (Threaded) or equivalent; Milwaukee 1509 (Solder) or equivalent.
- H. Check Valves - 2" and Smaller, Class 150: Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, Y-pattern, swing type design, bronze seat, composition disc, teflon seat disc for steam service, Buna-N for water service. Milwaukee 510 (Threaded) or equivalent; Milwaukee 1510 (Solder) or equivalent.
- I. Check Valves - 2 1/2" and Larger, Class 125: Valves 2-1/2" and larger shall be of ASTM A-126 Class B, cast iron, flanged ends, Class 125 construction, bolted bonnet, bronze trim, swing type design. Milwaukee F2974M or equivalent.

### **2.02 BUTTERFLY VALVES**

- A. Valves 2-1/2" and larger shall be full lug pattern, ASTM A-126, Class B cast iron body, 416-SS stems, aluminum/bronze disc, EPDM liner and seats (-30°F to 275°F) w/rigid phenolic cartridge, 200 PSIG working pressure with Bubble tight shut-off. Valves shall be for mounting between flanges with lugs drilled and tapped so that pipe may be disconnected on either side of valve with opposite end remaining under pressure. Milwaukee ML-123-E or equivalent.

- B. Valves 4" and smaller shall be provided with level handle operator with spring loaded lock stops. Valves 5" and larger shall be furnished with manual gear operator with hand wheel.
- C. Valves installed for insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing.
- D. Butterfly valves furnished for use in grooved piping system shall meet the material specification requirements as specified herein.

### **2.03 BALL VALVES**

- A. Valves 2" and smaller shall be cast of ASTM B-62 bronze, Class 150 construction, 600 PSI W.O.G. Two-piece body, chrome plated ball, blowout proof stem, reinforced TFE seats, non-asbestos packing. Milwaukee BA-100 (threaded) or equivalent. Milwaukee BA-150 (solder) or equivalent.
- B. Valves installed on insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing. Cutting or notching of the insulation or bending of handles shall not be permitted.

### **2.04 BALANCE VALVES**

- A. Valves 2" and smaller: Ball valve, bronze, Class 150 construction, 600 PSI W.O.G., Two piece body, Milwaukee BA-100 (threaded). Milwaukee BA-150 (soldered), as specified herein or equivalent.
- B. Valves 2-1/2" and larger: Lubricated plug valve, cast iron construction, 175 PSI W.O.G., Class 125 flange connections, level handle for valves 4" and smaller, manual gear operator with handle wheel for valve 5" and larger. Walworth No. 1797F or equivalent.
- C. Valves 2-1/2" and larger:
  - 1. Butterfly valve, full lug pattern, as specified herein.
  - 2. Furnish level handle with infinite throttling positions and locking device for securing handle in any position for valves 4" and smaller and manual gear operator with hand wheel for valves 5" and larger.
- D. Flow control and Flow Balance Valves: For calibrated flow balance valves and automatic flow control valves, see Specification Section 23 05 05, Piping Specialties.

### **2.05 NATURAL GAS VALVES**

- A. Valves 3/4" and Smaller: Bronze natural gas cock, Walworth No. 590 (square head), Walworth 591 (flat head) or equivalent.
- B. Valves 3" and Smaller: Ball valve shall be cast of ASTM B-584 bronze, Class 250 construction, threaded connections, chrome plated big ball and stem, RDTFE seat and stem packing, blow-out proof stem, UL Listed for natural gas service, Apollo 80-100 Series or equivalent.
- C. Valves 4" and Larger: Lubricated plug valve, cast iron construction, 175 PSIG W.O.G., threaded connection for valves 2" and smaller, Class 125 Flange connections, level handle operator. Walworth No. 1797F (Flanged) or equivalent.

### **2.06 MANUAL AIR VENTS AND DRAIN VALVES**

- A. For manual air vents and drain valves, see Specification Section 23 05 05, Piping Specialties.

### **2.07 NON-SLAM SILENT CHECK VALVE**

- A. Check valves for pump discharge and other required non-slam silent operation, shall be center guided, suitable for vertical or horizontal installation position, cast iron in semi-steel body, bronze disc and trim, stainless steel spring, Buna-N seats, Class 125 or

250 construction, as required by the application, wafer or globe flanged pattern for valves 2" through 10" size and flanged pattern for valves 12" and larger. Milwaukee 1400 Series (wafer) or equivalent. Milwaukee 1800 Series (globe) or equivalent.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. All valves shall be installed in locations which will allow easy operation and facilitate maintenance.
- B. Gate and Globe valves shall be installed with stems horizontal.

**END OF SECTION**



**SECTION 23 05 49**  
**HVAC AND ELECTRICAL INSTALLATION COORDINATION**

**PART 1 GENERAL**

**1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

**1.02 RELATED DIVISIONS AND SECTIONS**

- A. Section 23 05 00, Common Work Requirements for HVAC.
- B. Section 23 09 00, Facility Management System.
- C. Division 26 for Electrical.
- D. Division 28 for Electronic Safety and Security.

**1.03 SCOPE**

- A. It is the intention of this section to summarize the coordination of effort defined in the related sections and divisions of this specification.
- B. If there is a conflict between this Section and other Sections and Divisions of this specification, this Section shall be the governing and decisive Section.
- C. Make all connections to motors and controls for equipment supplied and/or installed under Division 23 according to Table 1 on the following page.

**PART 2 PRODUCTS**

Not Applicable.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. No work shall be performed until the reviewed and marked submittal data have been reissued to the Contractor, unless written permission is obtained from the Architect.

**TABLE 1**

<b>Item or System</b>	<b>Note</b>	<b>Supplied By (3)</b>	<b>Installed By (3)</b>	<b>Powered By</b>	<b>Control Field Wiring By</b>
Equipment Motors		Div. 23	Div. 23	Div. 26	N/A
Motor Control Center Including Starters, Pilot Lights, Heater, Switches, Auxiliary Contacts, and Internal Control Wiring		Div. 26	Div. 26	Div. 26	Div. 25
Stand Alone Motor Starters (outside motor control centers)	(1)	Div. 26	Div. 26	Div. 26	Div. 25
Variable Frequency Drives (VFD's)		Div. 23	Div. 23	Div. 26	Div. 25
Fused and Non-Fused Disconnects	(1)	Div. 26	Div. 26	Div. 26	N/A
Control Relays & Control Transformers	(1)	Div. 23	Div. 23	Div. 26	Div. 25
Boilers		Div. 23	Div. 23	Div. 26	Div. 25
Water Chillers		Div. 23	Div. 23	Div. 26	N/A
A/C Units Including Mixing Dampers		Div. 23	Div. 23	Div. 26	Div. 25
HVAC Unit Smoke Detectors		Div. 28	Div. 23	Div. 28	Div. 28

Item or System	Note	Supplied By (3)	Installed By (3)	Powered By	Control Field Wiring By
Fire/Smoke Control Dampers & Smoke Dampers		Div. 23	Div. 23	Div. 26	Div. 28
Fan Coil Unit Condensate Float Switches		Div. 23	Div. 23	N/A	Div. 25
Supply, Return & Exhaust Fan with unit mounted 115 VAC 2-position damper actuators interlock with fan motor/starter		Div. 23	Div. 23	Div. 26	N/A
Non-FMS Control Devices Including Wall Switches, Timers, Thermostats		Div. 23	Div. 23	Div. 26	Div. 26
Chemical Treatment Systems		Div. 23	Div. 23	Div. 26	N/A
Facility Management System (FMS)	(2)	Div. 25	Div. 25	Div. 25	Div. 25
Fire Alarm System & Interface w/HVAC System		Div. 28	Div. 28	Div. 28	N/A

**TABLE NOTES:**

1. Unless specified to be supplied with the equipment
2. Division 26 shall provide 120 VAC power to each mechanical space and the central plant as indicated on the drawings. Any additional power, transformers, and distribution shall be provided by the Section or Division indicated.
3. Division 23 indicates the HVAC contractor or their designated representative including equipment suppliers, sub-contractors, etc. Division 25 indicates the Integrated Automation Contractor.

**END OF SECTION**

## **SECTION 23 0550**

### **VARIABLE FREQUENCY DRIVES**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, the Supplemental General Conditions, and General Requirements.

##### **1.02 RELATED SECTIONS**

- A. Section 23 05 00, Common Work Requirements for HVAC.
- B. Section 23 30 00, HVAC Air Distribution Systems and Equipment.
- C. Section 23 05 93, Testing, Adjusting and Balancing.
- D. Section 23 09 00, Facility Management System.
- E. Division 22, Section 22 05 50, for plumbing variable frequency drives.

##### **1.03 GENERAL**

- A. Variable frequency drives shall be coordinated with the equipment being furnished and the wiring coordinated with the Division 26 contractor.
- B. Do not connect power factor correction devices in the electrical circuit serving any variable frequency drive or the motor downstream of the drive.
- C. A single drive shall be employed to serve multiple motors as specified on the equipment schedule on the drawings. Separate overloads for each motor shall be provided.
- D. All associated equipment motors shall be inverter duty in compliance with standard NEMA MG 1 Part 31 to ensure the compatibility between the VFD and motor.
- E. Manufacturer's Qualifications: Firms regularly engaged in manufacture of variable speed ac motor drives of types and ratings required, whose products have been in satisfactory use in similar service for not less than five years. All Division 23, HVAC and Division 22, Plumbing variable frequency drives except VFD's factory furnished and installed with package HVAC air handling equipment, HVAC and plumbing package pumping systems, etc. shall be of one manufacturer/model series and be provided by the exclusive local representative for sole source responsibility of all aspects of sales, startup, service, training and warranty.
- F. Variable frequency drives shall be manufactured by Asea Brown Boveri (ABB), Series ACH 550, or equivalent.

##### **1.04 SUBMITTALS**

- A. Refer to Sections 23 05 00 for additional requirements.
- B. Product Data: Submit manufacturer's data including catalog information, performance data efficiency, harmonic distortion, RFI/EMI (Radio Frequency Interference/Electromagnetic Interference) specifications, installation instructions and general recommendations for each type or size of motor.
- C. The VFD manufacturer shall provide calculations as part of the shop drawing submittal specific to this installation showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by manufacturer to ensure compliance with IEEE Standard 519-1992, "Guide for Harmonic Control and Reactive Compensation for Static Power Converters."

- D. Shop Drawings: Submit dimensioned drawings of cabinet and front panel layout, showing accurately scaled switches, their layouts and proximity to associated equipment. Furnish control schematic connection diagram showing all field connections.

## **1.05 SCOPE**

- A. Furnish and install pulse width modulating (pwm) output wave HVAC Variable Frequency Drives (VFD) and control wiring between the VFD control system as specified in Section 23 0550.
- B. The Variable Frequency AC Motor Drive shall be designed to convert the 460 volt with a tolerated voltage window  $\pm 30\%$ , 3 phase, 60 Hz input power to 0 to 460 volt, 3 phase, 0-60 Hz variable frequency output power. The output frequency and voltage of the drive shall be variable such that a constant volts/Hz ratio is maintained throughout the operating range. The volts/Hz ratio shall be adjustable.
- C. The drive shall be capable of operating any standard "off-the-shelf," NEMA B Design, squirrel cage induction motor with a 1.15 SF. The full load amp rating of the drive adjusted as required for jobsite elevation and ambient conditions shall be not less than 5% greater than the FLA rating of the motor or VFD must be oversized.
- D. For maintenance purposes, the drive shall be capable of starting, stopping, and running with stable operation with the motor completely disconnected (no load).
- E. Equipment will be designed and manufactured in accordance with applicable current NEMA, IEEE Standard 519-1992, (IEEE Guide for Harmonic Content and Control), UL 508, ISC 6 Enclosures for Industrial Controls and Systems, and IEC 801-2, 801-4, 255-4 recommendations and be designed for installation per NEC. Equipment will have UL, CUL, or ETL Listing or CSA listing as approved and accepted by the state and local code authorities having jurisdiction.

## **PART 2 PRODUCTS**

### **2.01 VARIABLE FREQUENCY DRIVES**

- A. Each VFD shall be of the pulse width modulating design and shall consist of:
  - 1. A full-wave diode bridge rectifier to convert incoming fixed voltage/frequency to a controlled DC voltage.
  - 2. A DC bus filter with a power factor of .95 or better over the entire speed range.
  - 3. The drive efficiency shall be 97% or better at full speed and full load. Efficiency shall not be less than 80% at 50% speed and load.
  - 4. An inverter section to change the controlled DC voltage to a PWM adjustable voltage/frequency output for complete motor speed control. The inverter output will be generated by power transistors which will be controlled by six identical base driver circuits.
- B. The VFD shall include the following:
  - 1. The unit enclosure shall be NEMA Type 1, metal cabinet with front hinged access doors allowing access to all internal electric connections. Any VFD's mounted inside an equipment room with unducted return air and/or mounted in AHU (air handling unit) shall be furnished with NEMA type enclosure required by the local Construction Codes. All VFD's shall be UL Listed as plenum rated.
  - 2. Electronic switching components shall be insulated gate/bipolar transistors, (IGBT).
  - 3. An externally operated, door interlocked, fused disconnect switch or circuit breaker shall be provided. The base VFD shall be UL Listed with a short circuit interrupting rating of 100,000 symmetrical amps minimum without the need for input fuses. The

DC Buss output shall be fused separately or electronically protected, with an indicating pilot light.

4. An internal 115V AC control power circuit with transformer and protective fuses shall be included or 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others.
5. Provide solid state relay interface for remote start/stop in both VFD and bypass mode independent of safety circuits.
6. Low frequency/low voltage start with linear adjustable ramp up to pre-selected speed.
7. Controlled acceleration and deceleration, separately adjustable, shall be provided from 2 to 180 seconds with torque limit override acceleration protection, and regeneration protection.
8. Critical Frequency lock out to skip over frequencies that may cause unstable operation in equipment being controlled. Provide at least three separate lockout settings.
9. The VFD 'run permissive circuit' will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a system ready command/contact closure.
10. Furnish line reactors/inductors with minimum 5% impedance designed to provide proper protection of harmonics and transients for the drive input power line. This is a minimum requirement and the manufacturer shall furnish higher rated line reactors or isolation transformers as may be necessary to maintain specified maximum total harmonic voltage distortion. Line reactors/transformers shall be factory mounted and wired within VFD enclosure. The 5% impedance reactors may be from dual (positive and negative DC bus) reactors, or 5% impedance AC line reactors. VFD's with only one 5% DC reactor shall add AC line reactors.
11. EMI / RFI (Radio Frequency Interference/Electromagnetic Interference) filters. All VFD's shall include EMI/RFI filters onboard to allow the VFD assembly to be CE marked and meet product Standard EN 61800-3 for the First Environment restricted level.
12. All components must be accessible from the cabinet door for service. The control shall be microprocessor based and the control card shall be the same part number and fully interchangeable for all ratings and voltages of VFD's.
13. Drive must be designed for against the wall and/or floor mounted arrangements, as required by the project installation requirements.
14. The drive shall be software programmed to provide automatic restart after a power outage or trip from overcurrent, over voltage, under voltage or over temperature. A delay shall occur before restart to allow motor to stop completely. The drive shall shut down and shall require manual restart if the automatic reset/restart function is not successful within 3-5 attempts within a short time period.
15. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start). The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed.

16. The VFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.
  17. Furnish terminal strip for external interlocks, isolated from the line and ground.
  18. Furnish prewired keypad with 3-position HAND-OFF-AUTO switches/buttons and manual speed control that will incorporate "bumpless transfer" of speed reference when switching between "HAND" and "AUTO" modes. When in "HAND," the VFD will be started, and the speed will be controlled from the manual speed control. When in "OFF," the VFD will be stopped. When in "AUTO," the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference.
  19. The drive shall employ three (3) current limit circuits to provide trip-free operation:
    - a. The Slow Current Regulation limit circuit shall be adjustable to 125% (minimum) of the VFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
    - b. The Rapid Current Regulation limit shall be adjustable to 170% (minimum) of the VFD's variable torque current rating.
    - c. The Current Switch-Off limit shall be fixed at 255% (minimum, instantaneous) of the VFD's variable torque current rating.
  20. The overload rating of the drive shall be 110% of its variable torque current rating for one (1) minute every 10 minutes, and 140% of its "H" torque current rating for two (2) seconds every 15 seconds.
  21. The VFD shall have door interlocked thermal magnetic circuit breaker which will disconnect all input power from drive and all internally mounted options when bypass is required. The disconnect handle shall be thru-the-door type, and be padlockable in the OFF position.
  22. The VFD shall have input line fuses mounted in drive enclosure.
  23. The VFD shall be optimized for a 3 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up engineer. VFD shall reduce the carrier frequency based on actual VFD temperature that allows the highest carrier frequency without derating the VFD.
- C. The VFD shall have a programmable digital operator's keypad located in the front door of the drive enclosure which shall include the following features and requirements.
1. All VFD's shall have the same customer interface, including digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control (START/STOP, FORWARD/REVERSE, and speed adjust), for setting all parameters, and for stepping through the displays and menus.
  2. The VFD shall give the user the option of either 1) displaying a fault, or 2) running at a programmable preset speed or last speed known if the input reference (4-20 mA or 2-10V) is lost; as selected by the user.
  3. The VFD's shall utilize plain English digital display (code numbers are not acceptable). The digital display shall be a 40-character (2 line x 20 characters/line) LCD display. The LCD shall be backlit to provide easy viewing in any light condition. The contrast should be adjustable to optimize viewing at any angle. All set-up parameters, indications, faults, warnings and other information must be displayed in words to

allow the user to understand what is being displayed without the use of a manual or cross-reference table.

4. There shall be a built-in time clock used to date and time stamp faults and record operating parameters at the time of fault. The clock shall also be programmable to control start/stop functions, constant speeds and four (4) separate, independent timer functions that have both weekday and weekend settings.
  5. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The digital keypad shall be removable, capable of remote mounting and uploading/downloading parameters and HVAC specific Application Macros that shall provide one (1) command to reprogram all parameters and customer interfaces for a particular application to reduce programming time and initial start-up of multiple VFD's.
  6. VFD shall have RS-485 port. The standard protocols shall be Modbus RTU, Johnson Controls N2 bus, Siemens Building Technologies FLN and BACnet available. No additional hardware, firmware, gateways, etc., shall be required for these standard protocols. Optional protocols for Lon Works, Profibus, Ethernet, and DeviceNet shall be available, and have the protocol in each VFD. The use of third party gateways and multiplexers is not acceptable.
  7. All protocols shall be "certified" by the governing authority, non-certified protocols are not allowed. If additional gateway, hardware, etc., is required to obtain the BACnet, Modbus, etc., interfaces, the VFD manufacturer shall supply one (1) gateway, hardware device, etc., per VFD. Multiple VFD's sharing one (1) gateway, hardware, etc., shall not be acceptable.
  8. BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs (BACnet Interoperability Building Blocks) defined by the BACnet standard profile for a B-ASC.
  9. All wires to be individually numbered at both ends for ease of troubleshooting.
- D. The following operation information displays shall be standard on the VFD digital display. The display shall be complete English words (alpha-numeric codes are not acceptable):
1. Output Frequency
  2. Motor Current
  3. Calculated Motor Torque
  4. Calculated Motor Power
  5. DC Bus Voltage
  6. Output Voltage
  7. Heatsink Temperature
  8. Analog Input Values
  9. Keypad Reference Values
  10. Elapsed Time Meter
  11. kWh Meter
- E. The drive shall have the following field adjustments:
1. Five (5) programmable critical frequency lockout ranges to prevent the VFD from continuously operating an unstable speed.

2. PID setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. There shall be an independent, second PID loop that can be utilized to maintain setpoint of an independent process (i.e. valves, dampers, cooling tower bypass valve control, chilled water valve control, etc.
  3. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 mA and 0 - 10 volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.
  4. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices.
  5. Two (2) programmable analog outputs proportional to frequency, motor speed, output voltage, output current, motor torque, motor power, DC bus voltage, or active reference.
  6. Three (3) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; maximum voltage 30 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs must be true form "C" type contacts; open collector outputs are not acceptable.
  7. Two (2) independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
  8. Two (2) independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
  9. The VFD shall ramp or coast to a STOP, as selected by the user.
- F. Speed Command Input shall be via:
1. Keypad or manual speed control as selected by user.
  2. Two (2) analog inputs, each capable of accepting a 0-20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.

**2.02 USER SELECTABLE AUTOMATIC/MANUAL BY-PASS** (Operation of motor at full voltage at 60 Hz fixed speed).

- A. Input line fused disconnect (service switch) and/or fast acting fuses exclusive to the VFD will allow the VFD to be disconnected from the line prior to clearing upstream branch circuit protection to maintain bypass capability. Door inter-locked, pad-lockable circuit breaker will disconnect all input power from the drive and all internally mounted options, together with fully rated magnetic motor starters mechanically interlocked shall be used to transfer motor to line power. Transfer must occur in orderly fashion causing no component damage to either drive or motor. Manual bypass circuitry must be integral part of drive cabinet. Separate bypass or starter enclosure is not acceptable. The VFD shall be UL Listed by the drive manufacturer and UL508 label complete bypass assembly.
1. An output contactor, bypass contactor and VFD only disconnect/service switch and/or fuses will be provided. Overload protection shall be provided in both drive and bypass modes.
  2. Provide user selectable manual or automatic bypass.



3. Bypass designs that incorporate fuses common to both the VFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable, as a VFD input contactor is not a NEC recognized, lockable, physical disconnect and is an unacceptable means of safely disconnecting power to VFD.
  4. The drive / bypass shall provide single-phase motor protection and under-voltage protection of bypass, contactor coils, etc., shall be in both the VFD and bypass modes.
  5. The following operators shall be provided:
    - a. Bypass HAND-OFF-AUTO.
    - b. Drive mode selector.
    - c. Bypass mode selector.
    - d. Bypass fault reset.
- B. Furnish auxiliary contacts to monitor drive status with FMS. A drive failure of any kind shall produce alarm signal and FMS.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. The drive shall be installed in strict accordance with manufacturer instructions. A minimum of 42" clearance shall be maintained in front of drives.

#### **3.02 EQUIPMENT PROTECTION**

- A. Whenever possible drive shall be mounted within sight of motor that is controlled by drive. In the event that drive is not mounted within sight of motor, a disconnect will be installed (under Division 26) within sight of motor. If a disconnect is installed between motor and drive the drive supplier shall provide a 6" x 6" red engraved warning sign to be mounted at the disconnect which shall read as follows:

**"WARNING: TO AVOID DAMAGE TO FREQUENCY DRIVE DO NOT PULL DISCONNECT, EXCEPT IN AN EMERGENCY, UNTIL FREQUENCY DRIVE IS SHUTDOWN."**

- B. Drive shall include a coordinated AC transient protection system consisting of MOV's (Metal Oxide Varistors: phase-to-phase and phase-to-ground), a capacitor clamp, and 5% impedance reactors designed to protect itself against all normal transients and surges in the incoming power line, any grounding or disconnecting of its output power, and any interruption or run away of the incoming speed reference signal. Protection is defined as a normal shutdown with no component damage.
- C. In general the drive shall contain the following protective circuits. In the case of a protective trip, the drive shall STOP, and announce the fault condition in complete words (alpha-numeric codes are not acceptable).
1. Overcurrent trip 200% of the VFD's variable torque current rating.
  2. Overvoltage trip 130% of the VFD's rated voltage.
  3. Undervoltage trip 60% of the VFD's rated voltage.
  4. Ground Fault.
  5. Adaptable Electronic Motor Overload (I<sup>2</sup>t). The electronic motor overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits which protect the motor only at full speed are unacceptable.

### 3.03 OPERATING CONDITIONS

- A. +/- 10% line voltage variations.
- B. 5% incoming line frequency variations.
- C. Maximum output frequency variations shall be +/- .25%.
- D. FLA to meet or exceed UL/NEC table 430-150 of the minimum motor horsepower specified on the equipment schedule on the drawings.
- E. Ambient temperature.
  - 1. 0 to 50°C - NEMA 1 and 12 indoor enclosures: 1 thru 50 HP, 480 and 230 volt shall be capable of continuous operation as per VFD manufacturers documented/submittal data or VFD must be oversized.
  - 2. 0 to 40°C - NEMA 1 and 12 indoor enclosures: 60 thru 550 HP, 480 and 230 volt, shall be capable of continuous operation; from 49 to 50 Deg. C (104 to 122 Deg. F.), VFD current derate as per VFD manufacturers documented/submittal data or VFD must be oversized.
  - 3. 0 to 50°C - NEMA 3R outdoor enclosures inclusive of all HP and voltages shall be capable of continuous operation as per VFD manufacturers documented/submittal data or VFD must be oversized.
- F. Altitude.
  - 1. 0 to 3300 feet above sea level without deration.
  - 2. Derate per manufacturer's recommendation for project elevations above 3300 feet.
- G. 90% Maximum humidity (non-condensing).

### 3.04 TESTING AND DOCUMENTATION

- A. Manufacturer to conduct standard factory tests to assure compliance with specification requirements.
- B. Manufacturer's local Designated Service Station's startup technician shall provide field startup and commission of all VFD's and shall demonstrate trouble free, stable operation for conditions of starting, full load, three quarter load, half load, quarter load, no load and intermediate loads. The local Designated Service Station shall have factory trained and certified applications engineer/service personnel to provide service, training and warranty onsite 24/365 (24 hours / 365 days per year) and a toll-free support line. Provide four (4) hours onsite training of programming and operation.
- C. Field tests shall include 100 hours of operation under load to demonstrate adequacy of equipment under thermal and voltage stresses, and that harmonic and other interferences do not adversely affect the electrical instrumentation and communications systems.
- D. Manufacturers technically qualified and factory trained representative to make final written documents of installation, inspection and test run.
- E. Field testing to include demonstration of automatic restart under operation of the following existing controls:
  - 1. Fire Alarm.
  - 2. Nitestat.
  - 3. OFF/AUTO Switch.
  - 4. Clock Control.
  - 5. FMS START/STOP in both VFD and BYPASS MODE.

- F. Switching from bypass to VFD operation both manually and automatically that shall be user selectable.
- G. Complete records of test procedure and results to be made available at no additional cost to purchaser's representative.
- H. Equipment shall carry a two (2) year guarantee as to workmanship, material, and satisfactory functioning from date of startup or maximum of 30 months from date of shipment from factory.
- I. Furnish complete sets of their drawings showing control schematics, transistor schematics, wiring, outline dimensions, mounting details and equipment weight.
- J. Operating & Maintenance Data and Spare Parts List - Furnish copies of all instruction books, spare parts lists and special bulletins covering on-site installation and operation in accordance with Section 23 05 00.

**END OF SECTION**



## SECTION 23 05 93

### TESTING, ADJUSTING AND BALANCING OF MECHANICAL SYSTEMS

#### PART 1 GENERAL

##### 1.01 GENERAL

- A. Conform with applicable provisions of the General Provisions and the General Requirements.
- B. Testing, adjusting and balancing (TAB) shall be performed by a TAB Agency which is independent of the Mechanical Contractor.
- C. The TAB Agency's efforts shall be paid for by the Contractor and included in the mechanical contract price.
- D. Unless specifically noted, all work specified in this section shall be included in the scope of the TAB Agency's work. But some work described in this section is to be performed by the mechanical contractor, controls contractor, or others, and that work is specifically noted to be by these entities.

##### 1.02 SCOPE

- A. Provide TAB for the systems and equipment installed under Division 23, including but not limited to:
  - 1. Supply and exhaust air systems including process and kitchen systems.
  - 2. Return air where specifically noted.
  - 3. Hydronic systems including domestic HW return systems.
- B. Provide all labor, instruments, and tools necessary to test, adjust and balance the systems shown on the drawings and/or described in these specifications. Check equipment performance, take measurements, adjust systems and equipment to provide specified performance, and report results. Submit reports to keep all parties posted on the progress of the TAB work.
- C. Where the TAB effort indicates deficiencies in system performance, TAB Contractor shall take the lead in a collaborative effort to trouble-shoot and resolve these deficiencies. Engage the assistance of others where necessary, starting with the Mechanical Contractor and Controls Subcontractor. Take additional measurements as required to identify the cause of the deficiencies, perform additional TAB as required to bring the system in compliance with the design intent. Engage the assistance of the Engineer and others where necessary. Indicate final setpoints and readings in a final TAB report.
- D. Include three days of effort on site for tests and/or balancing as directed in writing by the Owner's Representative beyond that described herein, but prior to substantial completion.
- E. Include two days on site for TAB efforts as directed in writing by the Owner's Representative after substantial completion.

##### 1.03 STANDARDS AND DEFINITIONS

- A. Perform all work in accordance with these specifications and the latest edition of the NEBB Standards.

- B. Air Handling Unit: Where the term Air Handling Unit (AHU) is used in this spec section, it shall include any factory fabricated or field erected unit that includes a fan and other components which filter, heat, cool, humidify or dehumidify the air stream. But the term AHU, where used in this section, does not include fan powered terminal units, fan coil units, unit heaters, cabinet unit heaters, etc.
- C. Air Handling System: A fan or AHU and ductwork.
- D. Hydronic System: A system in which a liquid is used to convey heat.
- E. Record or Report: Where used as a verb, these terms mean to include in the TAB report.

#### **1.04 QUALIFICATIONS**

- A. TAB agencies shall meet the following qualifications:
  - 1. Membership in the Associated Air Balance Council (AABC), National Environmental Balance Bureau (NEBB) or the Testing, Adjusting and Balancing Bureau (TABB).
  - 2. An office located within a 100 mile radius of the project site.
  - 3. A minimum of five (5) years experience in the TAB field.

#### **1.05 SUBMITTALS**

- A. Mechanical Contractor shall submit the name of the proposed TAB agency prior to the TAB agency performing any services.
  - 1. Submit a list of proposed personnel, including resumes with related project experience and certifications.
  - 2. Submit proposed TAB procedures, instrumentation and measurement equipment including calibration data, and proposed sample TAB report forms.
- B. Pre-Construction Report: Prior to the Mechanical Contractor installing the systems, the TAB Agency shall submit a letter indicating whether the design includes all devices the TAB Agency will need to successfully perform the TAB work. If any additional balancing devices are needed, the TABB Agency shall so note this in the pre-construction report.
- C. Submit TAB reports as noted herein. Reports shall be in both hard copy and PDF format.

#### **1.06 TAB PREPARATION AND COORDINATION**

- A. Mechanical Contractor shall perform the following in a timely fashion:
  - 1. Provide the TAB Agency with the project documentation (drawings, specifications, bulletins, submittals, shop drawings, etc.) necessary to perform the TAB services.
  - 2. Install, fill, pressure test, start up, clean, and the vent systems to be tested and balanced.
- B. Controls Subcontractor shall perform the following in a timely fashion:
  - 1. Install and make operational all necessary control systems and equipment, including computers and computer programs.
  - 2. Provide qualified personnel to operate the systems as necessary to support the TAB effort. Provide the TAB contractor with the computer software necessary to facilitate the TAB effort.

3. Assist as required to resolve problems which become evident due to TAB work, and as required to obtain specified system performance.

## **PART 2 PRODUCTS**

### **2.01 EQUIPMENT**

- A. Provide all equipment and instruments necessary to perform the work specified herein. Calibrate and maintain instruments per NEBB Standards. Provide not less than the following:
  1. Pitot tubes and draft gauges.
  2. Flow hood.
  3. Velometer.
  4. Thermometers.
  5. Pressure gauges.
  6. Flow meter test kit.
  7. Ampere – voltmeter.
  8. Speed indicator.
  9. Sound meter to measure eight octave bands.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Review and inspect the mechanical systems for conformance with design documents. Test, adjust and balance all system flows under design conditions and under other conditions where part load testing is specified. Comply with measurement tolerances per NEBB. Balance to within 10% of design flows unless otherwise specified.
- B. Visually mark the final settings of balancing dampers, balancing valves, fan speed controls, etc.
- C. Comply with NEBB Standards. The descriptions included herein are a guide to the minimum information needed.
- D. Troubleshooting: In the event that any areas fail to get proper flow, take the lead in troubleshooting the system. Measure pressures, flows, etc. at various points throughout the systems as required to identify the cause of the deficiencies and identify upgrades which will resolve these deficiencies. Coordinate any remedial efforts directly with mechanical and controls contractors and re-test as required.

### **3.02 TEST AND BALANCE REPORT**

- A. Report shall be 8-1/2" x 11" bound into a complete and coherent report, except that drawings may be larger size, but still bound into the report. All forms shall be typewritten or legibly handwritten.
- B. Include the following sections in the order indicated:
  1. Cover sheet with the Project Name, Location, and the names of the Mechanical Contractor and Engineer
  2. Table of Contents
  3. Summary indicating the highlights of the report and summarizing any deficiencies and recommendations
  4. Test results including the names of the persons performing the tests and dates the tests were performed

5. Drawings
  6. Description of the test procedures used
  7. List of instruments used along with their calibration data
  8. Qualifications of personnel
- C. Submit five copies and a PDF of the complete TAB report minimum two weeks before the first O&M instruction session. One copy will be returned to the Contractor with review comments.

### **3.03 BASIC AIR HANDLING SYSTEM TESTING, ADJUSTING AND BALANCING**

#### **A. General**

1. Test all fans and air handling systems. Balance systems to achieve specified air flows while minimizing throttling losses.
2. Air Flow Measurements: Fan and AHU flow rates may be determined by pitot tube traverse or by measuring fan speed, suction and discharge pressures, and comparison with the fan curve. Measure duct air flows using pitot tube traverses. Measure air flows of grilles, registers and diffusers using either capture hoods or pitot tube traverses in the connected ductwork. Make such other tests as may be required to demonstrate that systems perform per the design requirements.
3. Air Flow Measuring Stations: Calibrate each air flow measuring station which is provided as part of the construction contract. Use duct pitot tube traverses or other appropriate means to measure air flows. Coordinate with the flow measuring station supplier, and enter calibration coefficients into the FMS. Record the results of this effort.
4. Alert Mechanical Contractor and Engineer if any fan or air handling unit (AHU) appears to be operating in an improper or unsafe condition.
5. Seal all test holes in ductwork once testing is complete. Repair insulation jackets to maintain the integrity of the vapor barrier.
6. Include in the report copies of ductwork drawings with test points indicated.
7. Variable Flow Systems: Verify proper fan tracking from full flow to 50% flow.

#### **B. Fans: Perform the following for all fans, including those provided as part of an AHU.**

1. Fan Nameplate: Record unit number per the equipment schedule, manufacturer, model, size, and serial number.
2. Performance Data: Measure air flow and adjust fan speed to achieve required flow. Record air flow, static pressure rise and fan speed.
  - a. Advise when belt and/or sheave changes are required to achieve the design flows. Mechanical contractor shall make the necessary changes as part of the mechanical contract. Approximately 25% of fans may require a sheave and/or belt change.
3. Current and Voltage: Record motor nameplate and measured voltage and amperage. Advise if motor amps exceed rated load amps.

#### **C. Air Handling Units:**

1. Outside Air: Test outside air flows using a pitot tube traverse and balance as required. If a traverse is not practical, use the mixed air temperature method if the inside and outside temperature difference is at least 20 deg F, or use the difference between pitot tube traverses of the supply and return air ducts.



2. Static Pressure: Measure and record the static pressure at the inlet and outlet of each AHU component, including louvers, dampers, filters, coils, etc, and at each inlet and discharge duct connection.
- D. Coils: Measure and record air and water flows and pressure drops.
- E. Air Distribution Systems:
1. Zone, Branch and Main Ducts:
    - a. Adjust to within 10% of design air flows. Balance so that at least one zone balancing damper is wide open. Balance multi-diffuser branch ducts so that at least one outlet or inlet damper is wide open.
  2. Air Terminal Units:
    - a. Calibrate flow sensors and enter design maximum and minimum flow setpoints into FMS.
    - b. Record terminal unit number, size, specified flow, agency measured flow, FMS measured flow, and DDC flow correction factors.
  3. Diffusers, Registers and Grilles:
    - a. Test, adjust, and balance each diffuser, grille, and register to within 10% of specified design requirements. Record the size of each grille, diffuser, and register, initial flow measurement, and final measured flow.
    - b. Where rooms are indicated to be maintained at either positive or negative pressure, balance air flows to achieve these conditions under design flow conditions, and verify proper pressurization at minimum flow.
- F. Fan Coil Units, Unit Heaters, Cabinet Unit Heaters, Air Curtains, Door Fans, Fan Powered Terminal Units and other devices with fans and coils:
1. For each unit, record unit number, manufacturer, model, size, motor HP, voltage and rated load amps and design air flow.
  2. Measure and record initial air flows, along with final air flows, unit inlet and outlet static pressures, voltages, and motor amps.
  3. Measure and record initial and final water flows and pressure drops.
- G. Energy Recovery Units:
1. For each unit, record unit number, manufacturer, model, size, motor HP, voltage and rated load amps and design air flow.
  2. Measure and record initial air flows, along with final air flows, unit inlet and outlet static pressures, voltages, and motor amps.
- H. Duct Leakage Testing
1. Specification Section 23 30 00 describes the requirements for duct leakage testing. Provide all instrumentation and labor to take the required measurements.
  2. The Mechanical Contractor shall provide the fans and all other required work.
  3. Submit test report. Retest until ductwork complies with specified leakage criteria.

### **3.04 HYDRONIC SYSTEMS**

- A. General:
1. Prior to commencing hydronic balance:
    - a. Set valves to proper position per the sequence of operation. Open all coil valves to full open position. Set 3-way valves to full flow through system component.

- b. Check pump rotation.
  - c. Verify that system is adequately pressurized.
  - d. Set temperature controls so all system components deliver maximum flow.
  - e. Balancing may be done in sections.
2. Pumping Systems: Measure flows and determine operating characteristics of hydronic systems with pumps operating both independently and in parallel (where applicable). Make measurements at maximum flow.
  3. Balance systems to minimize throttling out in the distribution, and to instead throttle at the pump discharge. Recommend impeller trimming if appropriate.
  4. Measure and report performance readings on all pumps, coils, heat exchangers, heating and cooling water generating equipment, flow measurement devices, heat rejection equipment, etc. Measure and record the following for each item of hydronic equipment:

Eqpt Type		Pumps (Note 1)	Chillers	Air Cooled Condensers	Cooling Towers	Hot Water Boilers	Steam Boilers	Heat Exchangers	Coils				
Tag No.		X	X	X	X	X	X	X	X				
Nameplate Data	Mfgr	X	X	X	X	X	X	X	X				
	Model	X	X	X	X	X	X	X	X				
	Serial	X	X	X	X	X	X	X	X				
	Volts	X	X	X	X	X	X						
	RPM	X	X	X	X	X	X						
	HP	X			X								
	FLA	X	X	X	X	X	X						
	Refrigerant		X	X									
Scheduled	GPM1	X	X		X	X		X	X				
	Press Drop	X	X		X	X		X	X				
	GPM2		X					X					
	Press Drop		X					X					
Measured	GPM1	X	X		X	X		X	X				
	Inlet Press	X	X		X	X		X	X				
	Outlet Press	X	X		X	X		X	X				
	Press Drop	X	X		X	X		X	X				
	GPM2	X	X					X					
	Inlet Press	X	X					X					
	Outlet Press	X	X					X					
	Press Drop	X	X					X					
	Volts	X	X	X	X	X	X						
	Amps	X	X	X	X	X	X						

## Notes

- 1 For pumps measure pressure rise instead of pressure drop. Measurements for GPM2 shall be at shutoff conditions.
  5. Domestic HW return system: Balance to ensure HW availability throughout the system. Where balancing valves are provided, record flow and balance to provide flow in each circuit.

### **3.05 LIMIT DEVICES AND SAFETY CONTROLS**

- A. Limit Devices: Check all limit devices to verify proper operation, including, freezestats, flow switches, etc. Include in the TAB report a list of all such devices and the results of their tests.
- B. Fire and Smoke Dampers
  1. Test each fire damper, smoke damper, and fire/smoke damper to ensure proper operation. Record test results.
  2. Fire Dampers: Open access door, disconnect fusible link or activate thermal link, and verify that damper closes smoothly and completely. Reset damper and access door.
  3. Smoke Dampers: Open access door, activate damper, observe whether it closes smoothly and completely, and measure closing time. Reset damper and verify it opens completely. Close access door and record test results.
- C. Life Safety Controls: Test and record life safety control operation of the HVAC systems. Verify the installation of required smoke detectors in air handling equipment, and verify operation of the smoke detector by activating the smoke detector and observing air handler shutdown or other required functions as described on the control drawings and sequence of operation. With assistance from the contractors for mechanical, temperature controls and electrical work, verify the operation of interconnected systems, such as the smoke detector's activation of the fire alarm system and the alarm system's activation of the life safety control sequence.

### **3.06 SOUND TESTING**

- A. Measure sound level in approximately ten percent of rooms as directed by Engineer.
  1. Shut off mechanical equipment and measure background sound level in each octave band.
  2. Start mechanical equipment and measure sound level in each octave band.
  3. Submit a plot of measured data against noise criteria (NC) curves.
- B. Where measured sound levels are deemed by Owner to be unacceptable, work with Engineer and Mechanical Contractor to reduce actual levels, and retest as required.

**END OF SECTION**



## **SECTION 23 07 00**

### **MECHANICAL SYSTEMS INSULATION**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

##### **1.02 RELATED SECTIONS**

- A. Section 23 05 00, Common Work Requirements for HVAC.
- B. Section 23 05 04, Pipe and Pipe Fittings.
- C. Section 23 30 00, Air Tempering System and Equipment.

##### **1.03 SCOPE**

- A. Field insulation of piping: see drawings and Part 3 of this specification.
- B. Field insulation of ductwork: See drawings, Table 23 0700-1, and Part 3 of this specification.
- C. Field insulation of equipment supplied and/or installed under Division 23: See drawings and Part 3 of this specification.
- D. Factory-insulated equipment and materials are described on the equipment schedule, on the drawings, and in other sections of this specification.

##### **1.04 SUBMITTALS**

- A. Submit products to be used including insulation, jackets, miscellaneous products, and products for special applications. Review each application and advise if any product is either not suitable for, or not recommended for the application.
- B. Verify that each submitted product meets all requirements for that product as specified herein. Include literature that clearly shows products meet all aspects of the spec. Include a cover sheet or letter with the following statement:  
"Each product submitted here meets all specified requirements for that product except as follows:" followed by a list of any discrepancies.
- C. Submit schedules showing the type of product and thickness for each application. Indicate products to be used on valves and fittings. Indicate where vapor barriers will be provided and what jackets will be used.
- D. D-5, D-6 & D-7 insulation: If one of these insulations is specified, submit documentation indicating that the submitted materials are approved for the intended service.
- E. Submit a description of the application techniques to be used.

##### **1.05 QUALITY ASSURANCE**

- A. Comply with the latest edition of the National Commercial & Industrial Insulation Standards, as published by the Midwest Insulation Contractors Association.
- B. Part 3 and Table 23 07 00-1 give the system temperatures for various applications. Supplier shall review these temperatures and confirm the suitability of all components for the specified applications.
- C. Test piping and ductwork in accordance with applicable specification sections before insulation is applied.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. All materials must be 100% asbestos-free and 100% formaldehyde-free, NO EXCEPTION.
- B. All materials must be GreenGuard Gold Certified.
- C. Smoke and Fire Ratings: All materials shall have a composite fire and smoke hazard rating not exceeding flame spread 25, fuel contribution 50, smoke developed 50, when tested as assemblies per ASTM Standard E-84 or NFPA 255.
- D. Thermal conductivities: Per ASTM C518. Do not exceed the conductivities indicated. Units listed herein for conductivity are Btuh-in/SF-F. Resistance shall not be less than the values specified herein. Units for resistance are SF-F/Btuh.
- E. Noise Reduction Coefficients: Per ASTM C423 based on Type A mounting. NRC shall not be less than as specified.
- F. Jackets: Maximum 0.02 perm water vapor transmission per ASTM E96 Procedure A.
  - 1. ASJ: All service jacket per ASTM C1136 Type I, paintable white kraft paper outer surface reinforced with glass fiber yarn and bonded to aluminum foil, with self-sealing longitudinal lap and butt strips, breach puncture min. 50 oz-in/in tear per ASTM D781, tensile strength min. 30 lb/in per ASTM D828.
  - 2. FSK: Foil skim kraft per ASTM C1136 Type II.
- G. Fiberglass insulation: Inorganic fibers bonded with thermosetting resin.
- H. Approved Manufacturers: Owens Corning, Johns Manville, Knauf, Certain-Teed, Kflex, Armacell, Unifrax -Insulfrax, Industrial Insulation Group, Pittsburgh Corning. Where the term OAE is used herein, this refers to these manufacturers only. No other manufacturers are approved for this project.

### **2.02 PIPE INSULATION**

- A. General
  - 1. Valves, Fittings, and Accessories: Use the same insulation materials and thickness as the pipe insulation, except as noted.
- B. Type P-1, Fiberglass Pipe Insulation: Factory assembled insulation and ASJ. Pre-formed fiberglass per ASTM C547 Type I, suitable for use on surfaces from 0–850°F, with thermal conductivity 0.23 at 75°F or 0.33 at 250°F, and minimum 3 pcf density. ASJ shall have self-sealing lap at end and along length, with pressure sensitive tape lap sealing system. Owens Corning SSL II Pipe Insulation, Johns Manville Micro-Lok, Knauf Pipe Insulation.
  - 1. Where Type P-1 insulation is used, insulate fittings, valves and accessories using one of the following:
    - a. Fiberglass pre-formed fitting insulation complying with the specification for P-1 pipe insulation, Johns Manville Hi-Lo Temp insulation inserts, Hamfab, OAE. Finish with Type J-2 fitting covers.
    - b. Where pre-formed fitting insulation is not available, the following may be used: minimum 0.75 pcf density fiberglass per spec for D-1 insulation except without FSK. Finish with Type J-2 fitting covers or with two coats of fitting mastic with fiberglass fitting tape embedded between coats.

- C. Type P-2, Fiberglass Pipe and Tank Insulation: Similar to Type P-1 insulation and jacket, except with fibers oriented to allow insulation to be wrapped onto curved surfaces, with conductivity 0.30 at 100°F, or 0.55 at 400°F. Johns Manville Pipe & Tank Insulation, Owens Corning Pipe and Tank Insulation or Knauf Pipe and Tank Insulation.
  - 1. Alternate: Fiberglass board insulation similar to Type D2, scored for application on curved surfaces, with ASJ.
- D. Type P-3, Calcium Silicate Pipe Insulation: Rigid calcium silicate per ASTM C533, Type 1, asbestos-free, suitable for use on piping up to 1200°F, conductivity 0.55 at 700°F, compressive strength min. 200 psi at 5% compression. Industrial Insulation Group OAE.
  - 1. Fittings, valves and accessories: Insulate with mitered Type P-3 insulation or Type D-7 insulation.
- E. Type P-4, Elastomeric Foam Pipe Insulation: Pre-formed elastomeric foam, ASTM C534 Type 1 flexible, closed cell, suitable for use up to 220°F, UV protected, not to exceed flame spread 25 and smoke developed 50 based on 0.75-inch thickness, conductivity 0.30 at 75°F. Kflex, Armacell OAE.
  - 1. Fittings, valves and accessories: Insulate using either Type P-4 insulation pre-formed for use on fittings and valves, or cut sections of P-4 pipe insulation to match the shape of the fitting or valve, taped on using PVC tape.

### 2.03 DUCTWORK INSULATION

- A. Type D-1, Fiberglass Blanket: Factory fabricated insulation and FSK jacket assembly suitable for applications from 40-250°F, 3/4 pcf fiberglass, ASTM C553 Type I or II, with thermal resistance not less than the following for 2-inch thickness: 6.8 out of the box, 5.6 installed with 25% compression. Johns Manville Microlite XG Duct Wrap, Owens Corning Soft R Duct Wrap, Knauf Friendly Feel Duct Wrap, Certainteed Soft Touch Duct Wrap.
- B. Type D-2, Fiberglass Board: Similar to Type D-1 except rigid board type, 3 pcf density, thermal conductivity 0.23 at 75°F, NRC 1.36, suitable for unfaced side at up to 450°F and faced side at up to 150°F. Johns Manville 800 Series Spin Glas, Owens Corning 700 Series Board, Knauf Insulation Board, Certainteed Certra Pro Commercial Board
- C. Type D-3, Acoustic Lining (roll type): Organic fiber or fiberglass duct liner bonded with thermosetting resin, with factory-applied acrylic surface coating treated with anti-microbial agent, and factory-applied or shop-applied edge coating.
  - 1. Properties: Minimum 1.5 pcf density, thermal conductivity 0.24, 6000 FPM rated per UL 181, NRC 0.70 at 1-inch thick and .95 at 2-inch thick. The product (fiberglass, resin, coating, microbial agent and adhesive) as an assembly shall be suitable for surfaces and gases up to 250°F, and shall comply with ASTM C1071 (Type I), G21 and G22.
  - 2. Lining surface shall be cleanable using commercially available duct cleaning equipment when performed by qualified technicians using procedures established and recommended by the North American Insulation Manufacturer's Association (NAIMA) Duct Cleaning Guide.
  - 3. Johns Manville Linacoustic RC, Owens Corning Acoustic R duct liner, Knauf EM duct liner, Certainteed ToughGuard R Duct Liner.
- D. Type D-4, Acoustic Lining (board type): Similar to Type D-3 and complying with all aspects of the spec for Type D-3 insulation, except 3 pcf density rigid board with NRC 0.75 at 1-inch thick and 1.0 at 2-inch thick. Johns Manville Permacote Linacoustic R-300. Owens Corning Duct Liner Board, Knauf Rigid Plenum Liner, Certainteed Rigid Liner Board.

- E. Type D-5, Grease Duct Applications: High temperature, foil-encapsulated inorganic blanket, 8 pcf. Insulfrax Fyre Wrap Max 2.0, Johns Manville Fire Temp, OAE. Product shall meet the following when applied as 2-layers around a grease-duct:
  - 1. Tested and listed for zero clearance to combustibles across the entire surface of the blanket material per internal fire test AC101 or ASTM E2336 - Internal Fire Test – 2 Hr Grease Duct Enclosures.
  - 2. Rated as a 2-hr fire resistive enclosure assembly per ASTM E-119, Engulfment Fire Test for 2-hr Grease Duct Enclosure.
- F. Type D-6 –Combustible Materials within Plenum: For use on combustible materials located within supply or return air plenums, foil-encapsulated 8 pcf high-temperature ceramic fiber blanket suitable for service up to 1800°F. Unifrax Fyre-Wrap 0.5 plenum insulation.
- G. Type D-7 – Fire Rated Ductwork: Suitable for continuous operation at 1800°F, 6-pcf, foil-encapsulated inorganic blanket to provide a 2-hour rating per ISO 6944 when applied in a single 1.5-inch thick layer. Insulfrax FyreWrap 1.5 OAE.
- H. Type D-8 – Polystyrene Insulation: Rigid cellular square edge insulation per ASTM C578, waterproof, thermal conductivity 0.20, compressive strength 25 psi. Dow Styrofoam or Owens Corning Foamular.
- I. Type D-9 – Fiberglass Ductboard: Listed per UL 181 as a Class 1 Rigid Air Duct; conforming to ASHRAE Std. 62, NFPA-90A and 90B, ASTM G-21 & G-22; rated for 2-in. wg; constructed of fiberglass bonded with a thermosetting resin, with double density slip joints pre-molded in the board; FSK jacket; thermosetting acrylic polymer interior surface, and black interior surface color. Thermal conductivity 0.23, and NRC 0.70 at 1-inch thick and 1.0 at 2-inch thick. Johns Manville Superduct 475 or 800, Owens Corning Quiet R Duct Board, Knauf Duct Board M, Certainteed ToughGard Duct Board

## **2.04 EQUIPMENT INSULATION**

- A. E-1, Removable Insulating Blanket: Factory fabricated, one-piece, removable and re-usable insulating blanket with fiberglass insulation completely enclosed within a silicone coated fiberglass cloth with draw cords of SS or PTFE coated glass fiber, and stainless steel clips. Insulation thickness shall be as specified elsewhere, but not less than 1-inch. Energy Systems Inc. "Q-Master" OAE.

## **2.05 INSULATION JACKETS**

- A. Type J-1, Metal Jacket: 0.010-inch smooth Type 304 stainless steel or 0.016-inch smooth or embossed aluminum per ASTM B-209, with minimum 1-mil polyethylene film with protective layer of 40 Lb virgin kraft paper, continuously laminated to full width inside jacket. Childers OAE.
  - 1. Where jacket diameter is 16–96 in: 0.016-in. SS or 0.020 in. aluminum.
  - 2. Equipment heads and all surfaces where jacket is greater than 96-inch OD: 0.020-inch SS or 0.024 inch aluminum.
  - 3. Fittings and Accessories: Provide the same jacket material as for pipe.
- B. Type J-2, PVC Jacket: Minimum 20 mil sheets and 30-mil pre-molded fitting covers, ASTM D1784, Class 16354-C. Accessories include solvent weld solution, stainless steel tacks, and tape. All components shall be white, UV resistant, with paintable exterior surface, and suitable for use at –20 to +150°F. Johns Manville System 2000 (sheets), Zeston 300 (fitting covers), and Perma-Weld (solvent cement), OAE.
- C. Type J-3, Canvas Jacket: 10 x 10 fiberglass mesh.



## **2.06 MISCELLANEOUS PRODUCTS**

- A. General:
  - 1. Tapes: Aluminum, pressure sensitive, UL 181A-P listed and embossed, minimum 2.5-inch wide, Nashua 324A OAE.
  - 2. Duct Liner Adhesives: Water-based, complying with ASTM C916.
  - 3. Solvent Cement for PVC Jackets: Johns Manville Perma-Weld OAE.
  - 4. Staples: Outward clinching, 0.5-inch galvanized steel
- B. Piping Systems:
  - 1. Pipe Hanger Insulation Inserts: Mechanical Pipe Shields Inc. "Snapp Itz" OAE.
- C. Ductwork Systems:
  - 1. Duct Liner Edge Sealer, Surface Sealer, Coatings & Adhesives: To meet ASTM C916. Johns Manville Superseal OAE.

## **2.07 SPECIAL APPLICATIONS**

- A. Handicap Lavatory Insulation Kit: Handi-Lav-Guard insulation kit per ANSI A117.1 with flexible vinyl finish.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Delivery, Storage and Handling: Deliver and store insulation materials in factory-supplied containers. Protect from moisture. Do not install any materials that have gotten wet, regardless whether they are subsequently dried.
- B. Store and apply materials in accordance with manufacturers' recommendations, but not less than the following minimum temperatures. Ensure surfaces are clean and dry prior to application, and for minimum two hours after application:
  - 1. Sealers, coatings, solvents and adhesives: 40°F.
  - 2. Tapes 50°F.
- C. Install in accordance with manufacturer's recommendations, NAIMA recommendations, and this spec. Provide good ventilation.
- D. Where vapor barriers are specified, ensure that the entire system is vapor sealed.
- E. Protect materials from water damage. Replace any materials that are water-damaged prior to substantial completion.

### **3.02 PIPING INSULATION**

- A. General: Insulate piping as indicated herein and/or on the drawings. Except as noted, insulate all valves, fittings, and accessories with the same material and thickness specified for the pipe. Where piping is specified with a separate insulation jacket provide this same jacket for valves, fittings and accessories. Vapor seal cold piping systems.
  - 1. Where insulation terminates, provide insulating cement beveled for a neat finish. For vaporsealed piping, coat with insulating mastic prior to applying insulating cement.
  - 2. Strainers and Suction Diffusers: Either Type P-1 or P-3 insulation. Make provisions to easily remove and re-install insulation.

3. Pipe Supports: Provide high density calcium silicate insulation or insulation inserts as specified. Maintain pipe jacket and vapor barrier at supports. If necessary, apply a heavy coating of vapor barrier mastic material to prevent condensation from forming on supports. Provide galvanized steel insulation shields to protect insulation and jackets at supports.
4. Penetrations Through Building Construction: Insulation shall be continuous where piping passes through walls, floors, and other construction. Where insulated piping passes through fire and/or smoke rated construction, provide a section of UL approved fire safing insulation to match the required insulation thickness, or provide an insulated pipe sleeve as manufactured by Pipe Shield, Inc., OAE.
5. Mechanical Couplings: Where mechanical couplings are permitted, insulate them as specified for fittings.
6. Steam Traps: Do not insulate.
7. Retrofit Projects: Match the thickness of existing insulation where new insulation adjoins existing. Integrate new vapor barrier with existing so the insulation barrier is continuous for both new and existing piping.
8. All voids formed by support saddles or other mounting or support hardware shall be filled with insulation.

B. Application:

Temp Range	Temp (F)	Insulation Type	Vapor Sealed	Pipe Size				
				Under 1	1 - 1.5	Over 2 - 3	4 & 6	8 & Larger
TR-1	60&Less	P-1 or P-4	Yes	1.5	1.5	1.5	1.5	1.5
TR-2	61 – 104	P-1	Yes	0.5	0.5	0.5	0.5	0.5
TR-3	105 - 140	P-1	No	1.0	1.0	1.0	1.0	1.0
TR-4	141 - 200	P-1	No	1.5	1.5	2.0	2.0	2.0

1. Temperature Range TR-1: Chilled water, refrigerant suction, condenser water (outdoor piping subject to freezing).
2. Temperature Range TR-2: Domestic cold water, makeup water, soft water, industrial water, process water of any type, non-potable water, HVAC make-up water (except insulation is not required for evap cooler makeup piping outdoors), interior horizontal roof drain and overflow bowls and piping, condensate drains indoors.
3. Temperature Range TR-3: Domestic hot water (including non-circulating HW within interior walls and chases) and domestic HW return except as noted.
4. Temperature Range TR-4: Heating water supply and return, low pressure steam condensate, pumped condensate return, engine cooling water.

C. Special Applications

1. Handicap Lavatories: Insulate domestic hot and cold water piping and P-traps exposed below handicapped lavatories with insulation kit specifically designed for the application.
2. Heat Traced Piping: Oversize insulation as required to accommodate heat tracing. Provide metal jacket.

3. Plastic pipe in return air plenums: Provide 0.5-inch type D6 insulation.
  4. Piping subject to freezing and heat traced piping: Insulate all such piping (including drain piping) with thicknesses specified, but not less than 1.5-inch thickness. Oversize insulation to accommodate heat tracing where indicated. Provide J1 jacket.
- D. Type P-1 & P-2, Fiberglass Insulation: Install in accordance with manufacturer's recommendations.
  - E. Type P-3, Calcium Silicate Insulation: Adhere to pipe or equipment using stainless steel wire. Provide removable J-1 jacket.
  - F. Type P-4, Elastomeric Foam: Seal all butt ends and longitudinal joints with Halstead Adhesive. When exposed to the weather, protect flexible tubing insulation with two coats of exterior weatherproof coating as recommended by manufacturer.
  - G. Jacketing: In addition to the finish and jacket specified for the particular type of insulation, provide the following:
    1. Indoor piping exposed to physical damage Type J-2, PVC
    2. Mechanical Eqpt Spaces: Exposed piping  
less than 8 ft above floor or operator platform Type J-2, PVC
    3. Exterior piping Type J-1, Metal

### 3.03 DUCTWORK INSULATION

- A. General:
  1. Insulate all ducts except those specified to be uninsulated. The following ductwork need not be field insulated:
    - a. Factory insulated ductwork and plenums.
    - b. Ducts with acoustic lining, provided the lining thickness matches or exceeds the required insulation thickness.
    - c. Exhaust ducts, except where noted.
    - d. Return air ducts, except where noted.
  2. See Table 23 0700-1 for additional information.
  3. Ensure that ductwork is leakage tested prior to applying insulation. Inspect ductwork and repair any deficiencies prior to applying insulation. Do not apply insulation over deficient ductwork or plenum construction.
  4. Ensure that ductwork is clean and dry before applying insulation.
  5. For ductwork with acoustic lining the drawings indicate the "clear inside duct dimension" required. Over-size ducts as required to provide the required air flow area.
- B. Type D-1, Fiberglass Blanket Insulation: Measure and cut insulation. Install so insulation is not excessively compressed at corners. For rectangular and flat oval ducts 24-inches and wider, provide stick pins and speed clip washers 18-inches on centers on the bottom, and clip off excess length of stick. Firmly butt insulation ends and longitudinal joints. Overlap jacket minimum 2-inches at end joints and longitudinal joints, staple on 6-inch centers, and continuously seal jacket. Provide vapor barrier mastic where ducts are indicated to be vaporsealed. Should gaps or fishmouths occur, re-staple and seal them with mastic. Use FSK tape and vapor barrier mastic to

seal all penetrations of the FSK jacket, such as pins, tears, and hangers. Neatly trim and seal insulation at access doors, ends, damper rod controls etc. Verify proper damper operation.

- C. Type D-2, Fiberglass Board Insulation: Attach with mechanical fasteners 12" on centers.
- D. Type D-3 & D4, Acoustic Lining: Ductwork dimensions indicated on the drawings are net air flow dimensions inside liner. Increase duct size to accommodate liner. Completely line the inside surfaces of ducts and plenums specified and indicated. Comply with the NAIMA Fibrous Glass Duct Liner Standard (FGDLS), manufacturer's recommendations, and this spec. Adhere liner with minimum 90% coverage of adhesive, and secure with mechanical fasteners and washers per FGDLS and manufacturer's recommendations. Fastener length shall be sufficient to limit compression of liner to 1/8" maximum. Coat all cut edges and surface penetrations with edge sealer. Provide metal nosing for liner leading edges at fan discharge and for all ducts with air velocities exceeding 3,000 FPM. Maintain minimum 18-inch clearance from electric resistance heaters. Interrupt liner at dampers and apply external insulation at these locations.
  - 1. Provide Type D-3 insulation for the 10 feet upstream of roof exhaust fans except in wet air streams.
- E. Type D-5: Install insulation in a 2-layer system per manufacturer's instructions, including the use of mechanical fasteners for the underside of ducts, butting or overlapping of joints, and offsetting of joints on outer layer.
- F. Type D-6: Install in accordance with manufacturer's instructions. Overlap seams and joints minimum 2-inches, affix with SS wire minimum 18-inches on centers, but not less than per manufacturer's recommendations, and tape seams and joints with aluminum tape.
- G. Type D-7: Install insulation in a single-layer system per manufacturer's instructions. Mechanical fasteners for the underside of ducts shall be adhered to the duct in a manner suitable for the operating temperatures (welded or other suitable method). Butt or overlap joints per manufacturer's recommendations.
- H. Type D-8: Wire in place with SS wire minimum 12-inches on centers, and provide J-1 jacket.
- I. Type D-9: Install per manufacturer's recommendations, NAIMA standards, and SMACNA Fibrous Glass Duct Construction Standards. Provide ship lap seams and joints.

### **3.04 EQUIPMENT INSULATION**

- A. General: Where specified elsewhere, equipment will be factory insulated. Insulate all equipment as noted herein except portions of equipment that are factory insulated.
  - 1. Fiberglass Board Insulation: Score, bevel, or miter to provide tight joints and secure in place with mechanical pin and clip fasteners and insulation bonding adhesive applied to underside surfaces, or with bands. Fill joints with insulation material and provide corner beads to protect edges of insulation.
  - 2. Cold Tanks and Equipment: J3 jacket with two coats of approved vapor barrier mastic.
  - 3. Factory Packaged Equipment: Field insulate the equipment and piping on factory-fabricated assemblies as if they were field installed, unless such items are factory insulated.

- B. Chilled Water Pumps: Construct a removable aluminum box with 1.5-inch Type D2 or D3 insulation, vaporsealed.
- C. HW Pumps: Do not insulate.

### **3.05 JACKETING**

- A. Type J-1, Metal Jacketing:
  - 1. Ducts: Slope jacketing to shed rain.
  - 2. Pipes: Install with seams at the 3 o'clock or 9 o'clock position to shed water. Band 12" on centers.
  - 3. Joints and Seams: Overlap joints minimum 2-inches. Caulk with a weatherproof caulk when located outdoors.
- B. Type J-2, PVC Jacketing: Secure in place with tacks and solvent welded joints. White PVC tape may be used indoors.
- C. Type J-3, Canvas Jacket: Apply mastic at a rate of 60 to 70 sq. ft. per gallon, embed fiberglass mesh, smooth all wrinkles and apply finish coat of Sealfas, or equivalent.

**END OF SECTION**

**TABLE 23 07 00-1 – DUCTWORK INSULATION**

<b>Service</b>	<b>Location</b>	<b>Condition</b>	<b>Insulation Type</b>	<b>Insulation Thickness (in)</b>	<b>Notes</b>
Supply Air, Makeup Air, Outside Air	Indoor	Concealed	D1	1.5	1, 6
Supply Air, Makeup Air, Outside Air	Indoor	Exposed	D2	1.5	
Supply Air, Makeup Air, Return Air	Outdoor	All	D8	2	2, 4, 7
Supply Rectangular Ductwork downstream of Terminal Units, Fan Coil Units, Heat Pumps, Blower Coils and Low Velocity AHU's	Indoor	All	D1	1.5	1, 3
Return Rectangular Ductwork upstream of Fan Coil Units, Heat Pumps, Blower Coils and Low Velocity AHU's	All	All	D1	1.5	1, 3
Ductwork indicated to be lined	All	All	D3	1	5
Ductwork indicated to be lined with 2-inch acoustic lining	All	All	D3 or D4	2	5
Single Wall Lined Plenums	All	All	D4	2	
Transfer Air Ducts	All	All	D3 or D9	1	
Exhaust Ductwork	Indoor	Concealed	D1	1.5	8
Exhaust Ductwork	Indoor	Exposed	D2	1.5	8
Kitchen Exhaust Ductwork	Indoor	All	D5	2-layers	
Plastic Piping and Ductwork within RA Plenums	Indoor	Concealed	D6	0.5	
Fire-Rated Ductwork Other than Kitchen Exh	Indoor	All	D7	1.5	
Boiler Breeching & Stack	Indoor	All	P1 or P2	3	
Boiler Breeching & Stack	Outdoor	Exposed	P1 or P2	3	4, 7

Notes:

- 1 Includes Supply Air Duct from Energy Recovery Units and Evaporative Coolers.
- 2 Provide acoustical liner as indicated on the drawings.
- 3 Delete Type D1 insulation if acoustical liner is indicated by plan notes or shown on the drawings.
- 4 Provide J1 Jacket.
- 5 In hospitals do not provide acoustical lining in supply ductwork or plenums downstream of the final filter.
- 6 Vaporseal ducts conveying cold air.
- 7 Seal outdoor ductwork to prevent ingress of moisture.
- 8 Insulate only the portion of exhaust ductwork between isolation damper and outside.

## **SECTION 23 09 00**

### **FACILITY MANAGEMENT SYSTEM**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. The entire Facility Management System (FMS) specified hereafter shall be approved and listed by Underwriters' Laboratories, Inc., under UL 864 (Energy Management and Control System).

##### **1.02 RELATED SECTIONS**

- A. Section 23 05 00, Common Work Requirements for HVAC.
- B. Section 23 05 05, Piping Specialties.
- C. Section 23 05 23, Valves.
- D. Section 23 05 49, HVAC and Electrical Installation Coordination.
- E. Section 23 05 50, Variable Frequency Drives.
- F. Section 23 05 93, Testing, Adjusting and Balancing.

##### **1.03 SCOPE**

- A. It is the intent of this Section to provide, install, connect, and calibrate the entire Facility Management System (FMS) as indicated on the Drawings and as necessary to provide fully automatic control for all systems as shown in the control drawings, stated in the sequences of operation, indicated in the electrical ladder diagrams, or as otherwise indicated in the Contract Documents. Some equipment controls may be specified to be provided in the Contract Documents outside this Section. As work of this Section, the Contractor shall coordinate with these other suppliers and trades to provide a completely integrated control system.
- B. It is the responsibility of the bidder to read and conform to all sections of the Specifications, review all Contract Drawings of all Divisions, and coordinate with all equipment suppliers of material specified under other sections of the Specifications including any Owner-furnished equipment.
  - 1. The engineering, installation supervision, programming, graphics development, calibration, startup, and checkout necessary for a complete and fully operational control system as specified hereafter shall be provided under this Section.
- C. Provide startup documentation verifying proper operation of all points and all integrated systems.
- D. Provide integration of electrical power systems, packaged air handling units, chillers, VFD's, boilers, into the FMS as outlined on the drawings, in the sequence of operations, or in the specifications.
- E. Provide training and instruction of the installed control system.

##### **1.04 APPROVED MANUFACTURERS**

- A. Facility Management System suppliers will be authorized factory representatives or branch offices of Delta Controls (Setpoint), or as approved by Owner.

##### **1.05 SUBMITTALS**

- A. Within thirty (30) days of contract award, submit shop drawings and submittal data in accordance with Section 23 0500 and the General Contract Requirements. These submittals shall be delivered first to the mechanical and electrical sub-contractors for coordination review and evaluation prior to being submitted for final review. Letters

from these sub-contractors verifying that they have reviewed the submittals, and any comments regarding the submittals, must be attached as part of the final submittal.

- B. Submittals shall consist of shop drawings, catalog data sheets, and point verification forms as defined in the following paragraphs.
1. Shop drawings shall be provided which show all control devices, electrical ladder diagrams, control system schematics, sequences of operation, and a material list. All systems and the associated control components, as well as all connections between components, shall be clearly indicated. The submittal shall clearly indicate the required coordination with equipment supplied by others, including any Owner-furnished equipment. Simply showing a connection with no identification or termination will be considered unacceptable. All connections shown on the Drawings shall be labeled on both ends and these same labels shall be used for the installation process for ease of comparing the shop drawings to the actual field installation. Each control component shall be given a unique identifier. This identifier shall be used in the sequence of operation so that reference to the Drawings can be easily made. A complete FMS communication and power architecture drawing shall also be included on the shop drawing.
    - a. Electrical ladder diagrams shall be shown on the shop drawings. Electrical ladder diagrams shall show all switches, relays, motor starters, etc. The electrical ladder diagrams shall show the correct control wiring and interlock wiring of all equipment provided under the Contract including any Owner-furnished equipment. Each diagram shall reference the correct power source by breaker panel and circuit number or from a control transformer. If equipment shown is provided by another Contractor, then this shall be noted.
    - b. The sequence of operation for each controlled system shall be provided with reference to the control device identifier. The sequence of operation shall break down the control operation by major function (i.e., mixed air control, occupied-unoccupied, smoke purge, etc.,) and describe in detail the correct operation and interaction with other system functions. Use of the sequence of operation stated on the Drawings is acceptable; however, it shall be modified to reflect actual control device identifiers.
    - c. A complete material listing shall be included on the shop drawings which show the device model numbers, device identifiers, quantities, manufacturers, etc., of all equipment provided under this Section. The material list shall be organized in alphabetical order so that it can be easily compared to the associated catalog data sheets. The quantities are to be provided only to confirm a general understanding of the contract requirements and will not be verified as a complete material list.
  2. Catalog data sheets will be provided for each different piece of equipment provided under this Section. At a minimum the data sheet shall contain sufficient information so that compliance with the Specification can be verified. Where multiple models or options are indicated on the same catalog data sheet, the equipment proposed shall be highlighted or otherwise indicated. The catalog data sheets shall be organized in alphabetical order to match the material listing on the shop drawings.



3. An integration plan shall be provided for each system being integrated into the FMS. The plan shall contain all systems, points, descriptions, addresses, and default values to be integrated. The contractor shall work with the system providers to compile this information prior to connection of the system to the FMS. This plan shall be submitted and approved by the Owner/Engineer before integration occurs.
  4. Point verification forms shall be completed for all points that will be installed as part of the FMS. Once approved, these forms shall be used during the testing and startup portions of this work. A template point verification form is located at the end of this Section.
  5. All Graphic Slides (or typical graphics for identical equipment) proposed for use on this Project shall be submitted for review and approval. The submitted slides shall be printed in color. All realtime display fields, user input fields, etc., shall be clearly indicated. No graphic software shall be installed on the job site until the Graphic Slides have been approved.
  6. Software Development parameters including all trend logs, reports, point alarm parameters, passwords, and scheduling shall be submitted based on the contents of this Specification Section. The information contained in this portion of the submittal will be followed during development of the programming code and shall be used for evaluation of the system's performance during the commissioning phase.
    - a. Report templates shall indicate what information will be presented on each report, how the information will be presented, report hard disk upload parameters, and report log file names.
    - b. If user authentication is required in any part of the installed system blank forms shall be submitted for completion of user information by the Owner. The forms shall allow the Owner to fill in the operator's name and approved password level. During Owner training, the FMS programmers shall coordinate with the approved operators to allow the operators to input their private passwords.
    - c. Blank schedule forms for each air handling system shall be submitted for completion by the Owner. Additionally, a blank schedule group form template shall be submitted so the Owner can identify schedule groups of HVAC equipment.
  7. The names, phone numbers, e-mail addresses, job descriptions, pager numbers, mobile phone numbers, etc., shall be provided for the project manager, project engineer, project programmer(s), installation foreman, and any other individuals key to the completion of this project. If at any time during the project the assignment of personnel changes, the Owner and the Engineer shall be notified and the previously listed information shall be furnished for the newly assigned individuals.
- C. All re-submittals shall contain a cover letter restating all of the previous submittal comments made by the reviewing engineer along with a written statement by the Contractor as to the resolution of each item. Any re-submittal issued to the engineer without this cover letter will result in an automatic rejection of the submittal.

## 1.06 RECORD DRAWINGS

- A. Record drawings shall be provided as required by Section 23 0500 and the General Contract Requirements. Record drawings shall not be completed until after installation is complete. Any changes made during installation shall be recorded on the approved shop drawings as they are made so that a current record drawing is constantly being updated. These as-constructed drawings shall be available at all time for inspection by the Owner's Representative. At completion of the project, all manual changes shall be incorporated into a clean reproducible set of as constructed drawings. These as-constructed drawings shall be available for use during the training sessions.
- B. With the reproducible record drawings the Contractor shall furnish a complete spare parts lists, operating instructions, and maintenance literature, for proper maintenance of all control equipment, in accordance with the requirement specified in Section 23 0500.
- C. In addition to the record drawings, the following documents and manuals will be delivered to the Owner. Two (2) sets of these documents will be provided prior to training begins:
  - 1. Names, address and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representative of each.
  - 2. Operators Manual with procedures of operating the control systems including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
  - 3. Programming Manual with a description of the programming language including syntax, statement descriptions including algorithms and calculations used, point database creation and modification, program creation and modification, and use of the editor.
  - 4. Engineering, Installation and Maintenance Manual(s) that explains how to design and install new points, panels, and other hardware; preventative maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
  - 5. A listing and documentation of all custom software created using the programming language including the point database. One set of magnetic media containing files of the software and database shall also be provided.
  - 6. One set of electronic media containing files of all color-graphic screens created for the project.
  - 7. Complete original issue documentation, installation, and maintenance information for all third party hardware provided including computer equipment and sensors.
  - 8. Complete original issue media for all software provided including operating systems, programming language, operator workstation software, and graphics software.
  - 9. Licenses and warranty documents for all equipment and systems.
  - 10. Recommended preventive maintenance procedures for all system components including a schedule of tasks, time between tasks, and task descriptions.

- D. Training Materials: The Contractor shall provide a course outline and training material for all training classes at least six weeks prior to the first class. The Owner reserves the right to modify any or all of the training course outline and training materials. Review and approval by Owner and Engineer shall be completed at least 3 weeks prior to first class.
- E. Operation and Maintenance Manuals: An updated as-built version of the control drawings and sequences of operation shall be included in the final equipment O&M manual submittal. The control drawings shall include:
1. A key to all abbreviations.
  2. Graphic schematic depictions of the systems and each component.
  3. Schematic system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
  4. A full points list with at least the following included for each point:
    - a. Controlled system
    - b. Point abbreviation
    - c. Point description (dry bulb temp, airflow, etc.)
    - d. Display unit
    - e. Control point or setpoint
    - f. Monitoring point
    - g. Intermediate point
    - h. Calculated point
  5. Detailed sequences of operation for each piece of equipment. They shall include, as applicable:
    - a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
    - b. All interactions and interlocks with other systems.
    - c. Detailed delineation of control between any packaged controls and the building management system, listing what points the BMS monitors only and what BMS points are control points and are adjustable.
    - d. Written sequences of control for packaged controlled equipment. Equipment manufacturers' stock sequences may be included. Provide additional narrative where needed.
    - e. Start-up, warm-up mode, normal operating, emergency operating and shutdown sequences.
    - f. Capacity control sequences and equipment staging.
    - g. Temperature and pressure control: setbacks, setups, resets, etc.
    - h. Detailed sequences for all control strategies, e.g., optimum start/stop, staging, optimization, demand limiting, etc.
    - i. Effects of power or equipment failure with all standby component functions.
    - j. Sequences for all level of alarms and emergency shut downs.
    - k. Seasonal operational differences and recommendations.

- I. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by the operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
- F. After final occupancy and all debugging have occurred, the Contractor shall prepare two (2) copies of all control software on non-volatile magnetic media and deliver them to the Owner.

#### **1.07 SYSTEM TESTING**

- A. The controls contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to and during functional performance testing. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:
  1. System name.
  2. List of devices.
  3. Step-by-step procedures for testing each controller after installation, including:
    - a. Process of verifying proper hardware and wiring installation.
    - b. Written program of sequence for BAS devices and controllers
    - c. Process of downloading programs to local controllers and verifying that they are addressed correctly.
    - d. Process of performing operational checks of each controlled component.
    - e. Plan and process for calibrating valve and damper actuators and all sensors.
    - f. A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
  4. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.
  5. A description of the instrumentation required for testing.
  6. Indicate what tests on what systems should be completed prior to Testing, Adjusting and Balancing (TAB) using the control system for TAB work. Coordinate with the Owner and TAB contractor for this determination.
- B. Upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, provide a signed and dated certification to the Owner and GC that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.
- C. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air and water pressure).
- D. At the termination of the testing period, the Contractor shall provide completed point verification sheets for each point in the FMS. These sheets shall be included as a part of the closeout notebook described in Section 23 0900-3.3-7. An example of a point verification form is included in Appendix C.

- E. Trend logs and graphs shall be developed as described in Section 23 0900-3.3-7 and Appendices A and B. Completed trend requirements shall be compiled into organized notebook(s) and delivered to the Engineer for approval before the final inspection and close-out of the project is performed.
- F. The Owner reserves the right to participate in or assign a representative to participate in the startup, testing, programming, or any other aspect of the construction of this project at no additional cost to the Owner.

## 1.08 TRAINING

- A. The controls contractor shall have the following training responsibilities, in addition to any listed in Division 1:
  - 1. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the Owner. In addition, copies of the system technical manual will be demonstrated during training and one copy submitted with each O&M manual. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all written control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Manuals will be approved by the Owner. Copies of audiovisuals shall be delivered to the Owner.
  - 2. The training will be tailored to the needs and skill-level of the trainees.
  - 3. The trainers will be knowledgeable on the system and its use. For the on-site sessions, the most qualified trainer(s) will be used. The Owner shall approve the instructor prior to scheduling the training.
  - 4. There shall be three training sessions:
    - a. Training I. Class Room. The first training shall consist of 8 hours of actual training. This training shall be held on-site. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
    - b. Training II. Hands -On. The second session shall be held on-site for a period of 8 hours of actual hands-on training after the completion of system QA. The session shall include instruction on:
      - 1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems.
      - 2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that CAN be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
      - 3) All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.

- 4) Every screen shall be completely discussed, allowing time for questions.
  - 5) Use of keypad or plug-in laptop computer.
  - 6) Use of remote access to the system via phone lines or networks.
- c. Training III. The third training will be conducted on-site six months after occupancy and consist of 4 hours of training. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

#### **1.09 SERVICE AND WARRANTY**

- A. The system supplier shall maintain a local maintenance support facility complete with system technicians, diagnostic and test equipment, and new spare components. Emergency service shall be available in the local office on a 24-hour, 7-day a week basis. The service agent shall provide a continuously monitored local service telephone number for emergency service and this number shall be provided to the Owner.
- B. Warranty all work as follows:
1. Labor & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner. Service during this period shall be available within 12-hours from the time the trouble call is placed.
  2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.
  3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by Owner must, however, be granted prior to the installation of such changes.
  4. The system provider shall provide a web-accessible system and support on-line resource that provides the Owner access to a question/answer forum, graphics library, user tips, upgrades, and manufacturer training schedules.

#### **1.10 OWNERSHIP OF PROPRIETARY MATERIAL**

- A. All project-developed hardware and software shall become the property of the Owner. These items include but are not limited to:
1. Project graphic images
  2. Record drawings
  3. Project database
  4. Project-specific application programming code
  5. All documentation

#### **1.11 PROGRESS PAYMENTS**

- A. When developing a schedule of values for the FMS and control systems, a minimum of 20% shall be reserved for activities after construction completion, including commissioning support, testing (functional performance testing and trend logs as required herein), record drawings, training, etc. Payment for these activities may be requested as they are completed.

## **PART 2 PRODUCTS**

### **2.01 GENERAL**

- A. All products required for this project shall be selected in accordance with this part of the Section. Installation of the components shall be in accordance with Part 3 of the Section. If a component is required to meet the requirements shown on the Drawings and is not specified in the Part of the Specification, the supplier shall select and submit on components that meets all design requirements indicated on the Drawings, stated in the sequence of operation, and elsewhere in the Contract Documents.

### **2.02 PRIMARY OPERATOR WORKSTATIONS**

- A. One (1) primary operator workstation/ server shall be provided including all necessary hardware and software requirements described herein. The workstation shall be connected to the FMS local area network directly.
- B. Hardware Requirements
  - 1. The minimum hardware requirements for the operator workstation shall include the following minimum requirements but in any case shall be of adequate capacity to easily accommodate the FMS software:
    - a. Desktop Computer with the latest Intel processor released in the past six months and a standard 102-key keyboard.
    - b. 160.0 Gbyte hard drive, read/write DVD
    - c. 256 Mbyte RAM minimum.
    - d. High resolution 22" LCD monitor and graphics adapter with 16 Mbyte memory minimum.
    - e. Serial Mouse or PS/2 Microsoft compatible mouse.
    - f. ETHERNET® Card and USB ports.
  - 2. One (1) color LaserJet printer shall be provided for connection to the primary operator workstation.
  - 3. The primary operator workstation[s] shall be used only as an interface to the LAN and shall in no way be necessary for the routine functioning of the FMS local area network or any FMS controller operation.
  - 4. Any and all additional interface equipment necessary to connect the Operator Workstation to the FMS network.
- C. Software Requirements
  - 1. The operating system for the operator workstation[s] shall be the latest version of Microsoft Windows released in the past six months.
  - 2. Software shall be provided for the operator workstation[s] which will allow operators to conduct business on the LAN simultaneously with any FMS controller in a full multi-user mode of operation. The following requirements define the minimum features which shall be provided as part of the Scope of Work of this Section.
    - a. Operator Interface

The primary operator workstation interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software.

The operator interface shall minimize the use of a typewriter-style keyboard through the use of a mouse or similar pointing device, and "point and click"

approach to menu selection. The users shall be able to start and stop equipment, change schedules, or change setpoints from graphical displays through the use of a mouse or similar pointing device.

At the option of the user, operator workstations shall provide consistent graphical or text-based displays of all system point and application data described in this Specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.

The operator interface shall provide the ability to simultaneously view several different types of system displays in a windowing environment to speed facility operation and analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze system performance.

User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices online.

b. User Access

Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as he/she deems appropriate for each user, based upon an assigned password.

A minimum of five (5) levels of access shall be supported and a minimum of 50 passwords shall be supported at each FMS panel.

Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel-mounted devices, shall be limited to only those items defined for the access level of the password used to logon.

c. System Interaction

The operator interface shall allow the operator to perform commands within any FMS controller on the FMS local area network including, but not limited to, the following:

- Startup or shutdown selected equipment.
- Adjust setpoints.
- Add/modify/delete time programming.
- Enable/disable process execution.
- Lock/unlock alarm reporting for each point.
- Enable/disable totalization for each point.
- Enable/disable trending for each point.
- Override PID loop setpoints.
- Enter temporary override schedules.
- Define holiday schedules.
- Change time/date.
- Enter/modify analog alarm limits.
- Enter/modify analog warning limits.
- View limits.



- Enable/disable demand limiting for each meter.
- Enable/disable duty cycle for each load.

All control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:

- Add/delete/modify standalone FMS panels.
- Add/delete/modify operator workstations.
- Add/delete/modify application specific controllers.
- Add/delete/modify points of any type, and all associated point parameters, and tuning constants.
- Add/delete/modify alarm reporting definition for each point.
- Add/delete/modify control loops.
- Add/delete/modify energy management applications.
- Add/delete/modify time- and calendar-based programming.
- Add/delete/modify totalization for every point.
- Add/delete/modify historical data trending for every point.
- Add/delete/modify custom control processes.
- Add/delete/modify any and all graphic displays, symbols, and cross-references to point data.
- Add/delete/modify dial-up telecommunication definition.
- Add/delete/modify all operator passwords.
- Add/delete/modify alarm messages.
- Add/delete/modify all FMS programs operating within the FMS panels and system.

Definition of operator device characteristics, FMS panels, individual points, applications and control sequences shall be performed through fill-in-the-blank templates.

#### d. Reports

Reports shall be generated automatically or manually, and directed at operator input to either CRT displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:

- A general listing of all points in the network.
- List all points currently in alarm.
- List of all off-line points.
- List all points currently in override status.
- List of all disabled points.
- List all points currently locked out.
- List of all items defined in a "follow-up" file.
- List all weekly schedules.

- List all holiday programming.
- List of limits and deadbands.

Summaries shall be provided for specific points, for a logical point group, for a user-selected group or groups, or for the entire facility without restriction due to the hardware configuration of the facility management system.

e. Third Party Interface

System data, including transactions, trends, alarms, totalization files, etc., shall be stored on the workstation disk drive in an industry standard database format (e.g., dBase IV) such that it is compatible with off-the-shelf third party database and spreadsheet programs.

f. Dynamic Color Graphic Displays

Color graphic site plans, buildings, building floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems, hot water boiler systems, and all other controlled or monitored systems shall be provided as specified in Part 3 of this Specification.

Dynamic point (actual or calculated) indication shall be shown in their respective locations, and shall automatically update to represent current conditions without operator intervention.

The windowing environment of the operator workstation shall allow the user to simultaneously view several graphics at the same time.

g. Graphic Generation Software

Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

A complete standard library of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.) complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols.

The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:

- Define symbols.
- Position and size symbols.
- Define background screens.
- Define connecting lines and curves.
- Locate, orient and size descriptive text.
- Define and display colors for all elements.
- Establish correlation between symbols or text and associated system points or other displays.

h. Database Save/Restore/Backup

Backup copies of all standalone FMS panel databases shall be stored in the operator workstations.

Continuous supervision of the integrity of all FMS panel databases shall be provided. In the event that any FMS panel on the network experiences a loss of its database for any reason, the system shall automatically download

a new copy of the respective database to restore proper operation. Database backup/download shall occur over the local area network without operator intervention. Users shall also have the ability to manually execute downloads of any or all portions of an FMS panel database to or from the operator workstation.

i. Trending and Trend Graphing

The software shall be capable of displaying realtime data from the FMS controllers or historical trend data retrieved from the operator workstation hard drive.

Capacity and features of the trending software and the associated trend graphing software shall be adequate to meet the requirements stated in Section 23 0900, 3.3 - 7 and as defined in Appendix A.

## 2.03 FMS CONTROLLERS

A. General

1. Standalone FMS controllers shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone FMS controller shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules, volatile and non-volatile memory, signal conditioners, etc.
2. The FMS controllers shall have UL-916 or equivalent CSA or ETL listings. The FMS/FMS field modules shall also conform to FCC Docket 20780, Part 15, Subparagraph B.
3. The FMS controllers shall be fully compliant with ANSI/ASHRAE Standard 135-2004 BACnet and all published addenda at the time of installation.

B. Hardware Requirements

1. Communications

- a. Each FMS Controller shall be equipped with the necessary hardware to permit connection to the FMS local area network described in this Section. All communications hardware shall be part of the standard manufactured product and no intermediary devices to establish communications shall be permitted.

2. Memory

- a. Each FMS Controller shall have sufficient memory to support its own operating system and databases including:
  - Control processes.
  - Energy management applications.
  - Alarm management.
  - Historical/trend data for all points.
  - Maintenance support applications.
  - Custom processes.
  - Operator I/O.
  - Dial-up communications.
  - Manual override monitoring.

- b. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
    - c. Should FMS controller memory be lost for any reason, the panel will automatically receive a download via the local area network, phone lines, or connected computer. In addition, the user shall have the capability of reloading the FMS controller via the local area network, via the local RS-232C port, or via telephone line dial-in.
3. Input/Output
  - a. Each FMS controller shall support inputs and outputs of the following types:
    - Type C digital inputs.
    - SPDT digital outputs.
    - Universal analog inputs which support all industry standard signals including 4-20 mA, 0-20 ma, 0-10 VDC, etc.
    - Universal analog outputs which support all industry standard signals including 4-20 ma, 0-20 ma, 0-10 VDC, etc.
    - Pulse Type C digital inputs.
    - SPDT pulsed digital outputs.
4. Communication Ports
  - a. FMS controllers shall provide at least one RS-232C serial data communication ports for simultaneous direct connection of operator I/O devices including portable operator terminals (future) and printers. FMS controller shall allow connection to the serial ports without interrupting the normal operation of permanently connected modems, printers, or network terminals.
5. Override Switches
  - a. Onboard hand/off/auto operator override switches shall be provided integral to the FMS controller for digital output points and positioning switches for all analog output points. The FMS controllers shall monitor the status or position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.
6. Status Indicators
  - a. The FMS controller shall have local status indication for each binary input and output without the need for an operator I/O device.
7. Surge and Transient Protection
  - a. Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980.
8. Expandability
  - a. The system shall be modular in nature, and shall permit expansion through the addition of workstation hardware, FMS controllers, sensors, and actuators.

9. On-Line Diagnostics
  - a. Each FMS controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of onboard electronics. The FMS controller shall provide both local and remote enunciation of any detected component failures or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each FMS controller, and shall not require the connection of an operator I/O device.
10. Power Failure Restart
  - a. In the event of the loss of normal power, there shall be an orderly shutdown of all standalone FMS controllers to prevent the loss of database or operating system software. Upon restoration of normal power, the FMS controller shall automatically resume full operation without manual intervention.

C. Software Requirements

1. General
  - a. All necessary software to form a complete operating system as described in this Specification.
  - b. All software routines and programs specified in this Section shall be provided as an integral part of the FMS controller and shall not be dependent upon any higher level computer for execution.
2. PID Control
  - a. The FMS controllers shall perform full proportional, integral, derivative (PID) control with all PID loops having the automatic control loop tuning feature.
3. Minimum Runtimes
  - a. The control software shall include a provision for all digital outputs to have minimum on/off cycle filters.
4. Staggered Starts
  - a. The control software shall include a provision for all digital outputs to electrical demand base start filters to prevent excessive electrical demand on the startup of equipment.
5. Automatic Restart
  - a. After an interruption of normal power, the FMS controller shall analyze the status of all controlled equipment, compare it with the commanded position and return all equipment ON or OFF as necessary to resume normal operation.
6. Energy Management Applications
  - a. The FMS controllers shall have the ability to perform all of the following energy management routines as standard sub-routines which do not require the application of customized software:
    - Time of day scheduling.
    - Calendar-based scheduling.
    - Holiday scheduling.
    - Temporary schedule overrides.
    - Optimal start.
    - Optimal stop.

- Night setback control.
  - Enthalpy switchover (Economizer).
  - Peak demand limiting.
  - Temperature compensated duty cycling.
  - Chiller sequencing.
- b. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. Programs shall be applied to building equipment as described in the Sequence of Operation.
- D. Custom Programming
1. The FMS controllers shall be able to execute custom, job-specific processes defined by the operator, to automatically perform calculations and special control routines.
  2. There shall be no restriction as to the ability of the operator to create any type of control logic using system inputs, calculated variables, Boolean Logic, etc.
  3. The software shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified primary operator station or printer, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote operator workstation.
- E. Alarm Management
1. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each FMS controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the FMS controller's ability to report alarms be affected by either operator activity at an Operator Workstation or local I/O device, or communications with other panels on the network.
  2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three (3) priority levels shall be provided. Each FMS controller shall automatically inhibit the reporting of selected alarms during system shutdown and startup. Users shall have the ability to manually inhibit alarm reporting for each point.
  3. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.
  4. Each FMS controller shall be capable of storing a library of at least 250 alarm messages. Each message may be assignable to any number of points in the panel.
- F. Report Routing
1. Alarm reports, messages, and files will be directed to a user-defined list of devices or disk files used for archiving alarm information.

#### G. Operator Log

1. Operator commands and system events shall be automatically logged to disk in personal computer industry standard database format. Operator commands initiated from direct-connected workstations, dial-up workstations, and local FMS controller network terminal devices shall all be logged to this transaction file. This data shall be available at the Operator Workstation. In addition, this transaction file shall be accessible with standard third party database and spreadsheet packages. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

#### H. Trend Analysis

1. The FMS controllers shall be capable of storing point history files for every analog and binary input and output at the same time. The point history routine shall continuously and automatically sample the value of all analog inputs at user definable intervals.
2. The FMS controllers shall also provide high resolution sampling capability in one-second increments for verification of control loop performance.
3. Trend data for the FMS controller as well as all associated ASCs and TCUs shall be stored at the FMS controllers, and uploaded to hard disk storage at the operator workstation when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file format compatible with third party personal computer applications.

#### I. Runtime Totalization

1. The FMS controllers shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this Specification.
2. The totalization routine shall have a sampling resolution of one (1) minute or less.
3. The user shall have the ability to define a warning limit for runtime totalization. Unique, user-specified messages shall be generated when the limit is reached.
4. The FMS controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

#### J. Event Totalization

1. Standalone FMS controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.
2. The event totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.
3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

### **2.04 TERMINAL UNIT CONTROLLER**

- A. A Terminal Unit Controller (TUC) shall be provided for each terminal unit as indicated on the Drawings and as listed in the equipment schedule. The TUCs shall be connected as part of a LAN or sub-LAN which shall communicate at not less than

9600 Baud. Each terminal unit controller shall communicate on a peer-to-peer basis with all units having equal authority. Provide a TUC space temperature sensor for each TUC.

- B. Each TUC shall execute application programs, calculations, and commands via a microcomputer resident on the TUC. The database and all application programs for each TUC shall be stored in readable/writeable non-volatile memory within the TUC.
- C. Each TUC shall contain both software and hardware to perform full DDC/PID control loops. TUCs shall be able to provide analog output, in addition to normal binary type output.
- D. Each TUC shall be able to support various types of zone temperature sensors, including temperature sensor only, temperature sensor with built-in local override switch, with setpoint adjustment switch.
- E. Each TUC for VAV application shall have built-in air flow transducers for accurate airflow measurement in order to provide the pressure independent VAV operation.
- F. Each TUC shall have a built-in detection circuit to monitor the presence of the power to the equipment, and in case of the absence of the power it shall generate an alarm to the Operator Workstation.
- G. Each TUC shall have LED indication for visual status of communication, power, and all outputs. All circuits shall be optically isolated.
- H. All TUC controllers shall be fully compliant with ANSI/ASHRAE Standard 135-2004 BACnet and all published addenda at the time of installation.

## **2.05 OPERATOR INTERFACE PANELS**

- A. The operator interface panel shall be a permanently mounted LCD display with keypad or touchscreen system. The LCD shall have a minimum of 80 characters on multiple lines. The operator interface panel shall connect directly to the FMS controller LAN or controller. Portable handheld devices shall not be approved.
- B. The operator interface shall allow the operator to perform commands within any FMS controller on the FMS local area network including, but not limited to, the following:
  - Startup or shutdown selected equipment.
  - Adjust setpoints.
  - Add/modify/delete schedules.
  - Enable/disable process execution.
  - Acknowledge alarms.
  - Enable/disable totalization for each point.
  - Enter temporary override schedules.
  - Define holiday schedules.
  - Change time/date.
  - Enter/modify analog alarm limits.
  - Enter/modify analog warning limits.
  - View limits.
  - Change password protection.



## 2.06 NETWORKING/COMMUNICATIONS

- A. Primary Local Area Network (LAN)
  - 1. The only FMS equipment connections to the primary LAN are the FMS controllers or routers and the operator workstations. All other FMS hardware shall reside on either the Controller LAN or the sub-controller LAN.
  - 2. All FMS devices that reside on the primary LAN shall be compatible with the ETHERNET®.
- B. FMS Controller Network (LAN)
  - 1. FMS controllers (if not on the primary LAN) and application specific controllers Interfaces within a specific building shall reside on the second tier LAN referred to as the controller LAN. The controller LAN shall begin at the building FMS controller or router and extend to one or more FMS controller LAN controllers located throughout the building.
  - 2. Access to system data shall not be restricted by the hardware configuration of the network. The hardware configuration of the network shall be transparent to the user when accessing data or developing control programs.
  - 3. Expansion of the network shall support any combination of FMS controllers.
  - 4. The network shall include provisions for automatically re-configuring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures. The local area network shall also provide for error detection, correction, and re-transmission to guarantee data integrity.
  - 5. Communications must be of a deterministic nature to assure calculable performance under worst-case network loading at speeds no less than 9600 bps. No collision-based network shall be accepted below 10 Mbps.
  - 6. Automatic synchronization of the real-time clocks in all FMS controllers shall be provided.
  - 7. Development of the controller LAN is work provided entirely under this Section of the Specification.
- C. Sub-Controller Local Area Network
  - 1. All lower level controllers associated with terminal unit controllers shall reside on the third tier LAN referred to as the sub-controller LAN.
  - 2. The sub-controller LAN shall operate RS-485 at a selectable speed of 9.6K or higher. Development of the sub-controller LAN is work provided entirely under this Section of the Specification.
- D. All products shall be new and of the latest manufacturer's design. Warranty of all products shall start on the date of final acceptance of the work.
- E. All products shall be provided complete with all mounting hardware, brackets, and miscellaneous accessories whether stated in the individual product specification or not. Specific product options that are required to meet all design requirements indicated on the Drawings, stated in the sequence of operation, shown on the electrical ladder diagrams, and elsewhere in the contract documents shall be specified when the product is ordered and indicated on the catalog data sheet provided with the submittal.

## **2.07 DUCT STATIC PRESSURE STATION**

- A. Provide at each duct static pressure measuring location a traverse probe capable of continuous monitoring of static pressure. The probe shall contain multiple static pressure pickup points along the exterior surface of the cylindrical probe, internally connected to their respective averaging manifold. Each probe shall be extruded aluminum construction with threaded end support rod and nut, and mounting plate with gasket. Each probe shall be sized to span the entire duct and not extend past either side. The probe shall not produce a measurable pressure drop and shall produce a non-pulsating signal with an accuracy of 0.5 percent of total span. Air Monitor Model STAT-Probe/1 or equivalent.

## **2.08 OUTSIDE AIR STATIC PRESSURE PROBE**

- A. Outside air static pressure probe shall be constructed of 10 gage, anodized aluminum with a 2" diameter FPT connection. The probe shall be capable of sensing the outside atmospheric air pressure to within 2 percent of the actual value when subject to radial wind velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal. Specification based on air monitor S.O.A.P.

## **2.09 ELECTRONIC DIFFERENTIAL PRESSURE TRANSMITTER**

- A. Electronic differential pressure transmitter shall be designed to measure the differential air pressure as indicated on the Drawings or as required. Pneumatic connections shall be 1/4" barbed and the enclosure shall be provided with holes for panel or field mounting. The output shall be a two wire 4-20 mA loop powered device with an input range as indicated in the Drawings but not more than twice the actual measure variable. The accuracy including linearity, hysteresis and repeatability shall be less than  $\pm 1$  percent. Setra model C264 or equivalent.

## **2.10 ELECTRONIC TEMPERATURE ELEMENT AND TRANSMITTER**

- A. Zone Space Sensors
  - 1. Each TUC or ASC controlling a single zone application shall be provided with a space temperature sensor. The space sensor shall include a thermistor packaged or RTD in the standard UC/sensor design, digital temperature display, timed override button, set point adjustment, and a maintenance communication port.
- B. All Other Temperature Sensors
  - 1. Thermistor temperature sensors connected to a TUC or an ASC shall be a Type II thermistor compatible with the attached FMS controller without the need for any signal conversion hardware. The accuracy of the thermistor shall be  $\pm 0.5$  deg F over the range of the sensor. Precon ST series or equivalent.
  - 2. RTD temperature sensors shall be 1000 ohm platinum having an accuracy of  $\pm 1$  deg F over the entire range. The associated unit mounting transmitter shall generate a linear 4-20 mADC loop powered signal with a maximum input impedance of 675 ohms at 24 VDC.
  - 3. Sensors used for mixed air application shall be 25' averaging type. The sensor span shall have a field set range of range of 32.0 deg F to 160.0 deg F.
  - 4. All chilled water sensors and sensors placed in locations susceptible to condensation (outside or in chilled and condenser water liquid lines with the potential to drop below the ambient dew point) shall be furnished complete with a NEMA 3R enclosure for the electronics. The sensors shall have an immersion length of one half the pipe's diameter plus the length of the pipe tap. The sensors shall have a range of 10.0 deg F to +230.0 deg F. Units shall be furnished complete with a brass thermowell.

5. Duct temperature sensors for supply air temperatures and return temperature shall be a minimum of 18" in length. The sensor span shall have a range of -30.0 deg F to +160.0 deg F.
6. Sensors used for outdoor air temperature shall be provided complete with a sunshield. The sensor span shall have a range of -30.0 deg F to +140.0 deg F.
7. All immersion water, except chilled water sensors, shall have an immersion length of one half the pipe's diameter plus the length of the pipe tap. The sensors shall have a range of +10.0 deg F to +230.0 deg F. Units shall be furnished complete with a brass thermowell.
8. All temperature elements provided for space temperature measurement shall be installed in a white plastic housing.

## **2.11 AIR FLOW STATION AND TRANSMITTER**

### **A. Pitot Tube Air Flow Element and Transmitter**

1. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surfaces of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probes, and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30 degrees. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plates(s), gasket, and signal fittings suitable for HVAC duct installation.
2. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular ducts) or at equal concentric area centers (for circular ducts) along the probe length.
3. Probes shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of  $\pm 2$  percent without the use of correction factors. The maximum allowable unrecovered pressure drop caused by the probes shall not exceed 0.025 inches WC at 2000 fpm or 0.085 inches WC at 4000 fpm. The number of probes required for each installation shall be in accordance with the manufacturer's design recommendations. The airflow traverse probes shall be Air Monitor Corporation Model VOLU-probe or equivalent.
4. Pitot tube type air flow element flow stations shall not be used if the manufacturer's recommended upstream and downstream clearances cannot be achieved in the installation. The Contractor shall use thermal anemometer air flow stations in these instances.
5. The transmitter shall be capable of receiving flow signals from the airflow traverse probe and producing an output linear and scaled for air volume. The transmitter shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output during normal operating mode. All transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling will be performed digitally in the on-board microprocessor via input pushbuttons. The transmitter will be available in multiple natural spans covering the range of 0.05 inches WC to 25.0 inches WC with an accuracy of 0.25 percent of natural span. The transmitter shall be furnished with a transducer automatic zeroing circuit and be capable of maintaining linear output signals on applications requiring 5 to 1 velocity

turndown. Transmitter shall have a NEMA 12 enclosure. This Specification applies to all airflow transmitters. Transmitter shall be Air Monitor VELTRON DPT 2500-plus or equivalent.

B. Thermal Anemometer Air Flow Station

1. The thermal anemometer air flow stations shall use instrument grade self heated Thermistor sensors with thermal temperature sensors. Flow measurement drift shall not exceed manufacturer's repeatability statement for the life of the equipment. The manufacturer shall provide test data for accuracy performance prior to bid date. Vortex shedding arrays are not acceptable. Auto zeroing sensors are not acceptable.
2. The flow station shall be duct mounted with glass encapsulated self-heated Thermistor and epoxy encapsulated temperature sensor. The sensor housing shall be constructed of Noryl with one to four probes (in accordance with the manufacturer's design guidelines). The support struts and support bracket shall be constructed of tubular aluminum.
3. The flow transmitter shall be totally solid state microprocessor based. The unit shall provide a separate analog signal averager for true averaging duct velocity output on ducts requiring multiple probes. The unit shall be 24 VAC powered, isolated from other devices and not grounded. Multiple series probes and averagers wired from a single transformer must be wired in phase. The flow transmitter shall have an aluminum enclosure.
4. The system shall operate over a temperature range of 30 to 160 degrees Fahrenheit. The system shall operate over a velocity range of 0 to 5000 FPM with a pressure drop of less than 0.005 inches WC at 2000 FPM. The unit shall have an accuracy of  $\pm 10$  ft./min for flow rates less than 500 FPM and a  $\pm 2$  percent of reading accuracy for flow rates greater than 500 FPM. The unit shall have a repeatability of  $\pm 0.2$  percent of scale and resolution of 0.4 percent of scale. All electronics shall be housed in a NEMA 12 enclosure if the unit is mounted outside in the environment.
5. The unit shall have a field selectable output of airflow rate. Ebtron Eliminator Gold series, or equivalent.

**2.12 ELECTRONIC HUMIDITY TRANSMITTER**

- A. The sensors shall have an accuracy of  $\pm 3.0$  percent R.H. over the range of 10 to 90 percent R.H. with an operating temperature range of at least -20 to 60 deg C. The transmitter shall output a 4-20 mADC loop powered signal over the full range of the transmitter and the input impedance shall not exceed 500 ohms at 20 VDC. The transmitter shall be specifically designed for use in measuring outdoor or duct humidity or indoor space applications as indicated.
1. Outdoor or duct mounted units shall be enclosed in a NEMA 4 enclosure with a black painted aluminum casing. Vaisala Model No. HMD 60 or equivalent.
  2. Space transmitters shall be KELE Vaisala Model No. HMW 60 or equivalent.

**2.13 CURRENT TRANSDUCERS**

- A. Current sensing transducers shall measure AC current of loads and shall output a 4-20 mADC signal over the measured range of 0 to 60 amps AC. Sensor shall have a minimum of 2.0 percent of full scale accuracy. Unit shall be split core design. Veris Industries Model H-921 or equivalent.

## **2.14 CURRENT SENSING SWITCH**

- A. Current sensing relays shall indicate the status of AC current of motor loads. The transistor switches shall be rated for switching controller DC current up to 0.1 amp continuously at 30 VDC. The setpoint of the contact operation shall be field adjustable from 1 to 135 amps AC. The switch shall be self powering with a switched load LED for local indication. Veris Industries Model H908 or equivalent.

## **2.15 AIR DIFFERENTIAL PRESSURE SWITCHES**

- A. Filter/Fan Status Switch
  - 1. Air differential pressure switches shall have an adjustable setpoint of from 0.05" W.C. to 12.0" W.C. One snap acting SPDT Type C switch shall be enclosed under a NEMA 1 enclosure with a 1/2" conduit opening. Contacts shall be rated for 10 amps at 120 VAC. Cleveland AFS series or equivalent.
- B. Static Pressure Safety Switch
  - 1. Air pressure switch shall be manually reset type, designed to sense static pressure and break an electrical circuit when the setpoint is exceeded. The setpoint shall be adjustable from 0.4" to 12" W.C. Unit shall be furnished and installed with a static pressure tip. Kele & Associates Model AFS-460 or equivalent.

## **2.16 ELECTRIC LINE VOLTAGE THERMOSTAT**

- A. The thermostat shall be of the bimetallic design with a SPDT set of contacts rated for 120 VAC at 25 amps. Thermostat shall have an adjustable set point of from 50 deg F to 86 deg F with a fixed differential of 2.0 deg F. The cover shall be metal. Barber-Coleman Model No. TC-195 or equivalent.

## **2.17 ELECTRIC FLOW SWITCH**

- A. The switch shall utilize a multi-segment paddle for use in pipes ranging in size from 1" to 8" with a maximum operating pressure of 150 psig and utilize a sealed bronze bellows packless construction. A snap acting SPDT switch rated for 16.0 amps at 120 VAC shall be installed in a NEMA 1 enclosure with 1/2" conduit knockout is used for indoor applications. Johnson F61 series or equivalent.

## **2.18 ELECTRIC LOW LIMIT (FREEZESTAT)**

- A. Freezestat shall have a 20' temperature-sensitive element designed to respond to the lowest temperature to which any 1' length of the element is exposed. The unit shall have an adjustable set point from 35 deg F to 45 deg F. The electrical rating of the two SPDT contacts shall be 10.2 full load amps at 120. Unit shall be complete with an external manual reset lever. Johnson A70 series or equivalent.

## **2.19 LIQUID DIFFERENTIAL PRESSURE SWITCH**

- A. Switch shall have an adjustable setpoint of from 0 to 150 psig and a minimum differential of 1 psig. One snap acting SPDT switch enclosed under a NEMA 4 enclosure with 1/2" conduit opening and rated for 5 amps at 120 VAC shall be provided. Kele & Associates Model 24-013 or equivalent.

## **2.20 CONTROL RELAYS**

- A. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting silver cadmium Form C contacts, enclosed in dust-proof enclosure. Relays shall be equipped with the necessary mounting base, DIN rail, labels, termination clips, etc., and a coil transient suppression devices. All relays for control by the FMS shall have 24 VAC coils. All other required relays shall have coil voltages appropriate for the installation. IDEC RH series or equivalent.

## **2.21 CONTROL TRANSFORMERS**

- A. Control transformers shall be provided where shown or where required to meet the sequence of operation. Control transformers shall be fused on both primary and secondary taps. Fusing shall not exceed 80 percent of the rated transformer output. Control transformers 100 VA and less may have internal secondary overload if desired but anything over 100 VA must be external fused. Control transformers over 100 VA supplying power to a control panel shall be located external to the control panel.

## **2.22 ELECTRIC-PRESSURE SWITCHES**

- A. The electric-pneumatic relay body shall be plastic with three 1/4" barbed connections. The body shall have holes for panel mounting and shall pass 0.2 SCFM at 15 psig. The coil power will be as required but no more than 120 VAC with a maximum power consumption of 6.5 watts. All electrical connections will be within a NEMA 1 enclosure. Barber Coleman Model No. AI-181 or equivalent.

## **2.23 PNEUMATIC PRESSURE GAUGES**

- A. Install all air pressure gauges on air lines to and from all thermostats (except room type), valves, air motors, controllers, and as shown on the Drawings, so that the operation of each air control device can be checked. Provide all gauges no less than 2" except where a gauge is furnished inside the case of an instrument with its face showing through the instrument case as an integral part of the manufacture of the instrument.

## **2.24 AUTOMATIC DAMPERS**

- A. All automatic dampers, except for mixing box dampers furnished with air handling units as specified on the Equipment Schedule, shall be furnished under this Section of the Specifications. These dampers shall be installed and mounted under Section 23 3000.
- B. Dampers shall be constructed of extruded aluminum with oilite bronze or Teflon bearings and trunnions of non-corrosive materials. Each blade shall have a positive closing butyl-rubber or neoprene edge seal, and spring-loaded side seals unless otherwise noted. Dampers shall have louvers designed so that the blades are interconnected to give parallel movement. Jack shafting shall be provided for all dampers greater than 24" by 24". Ruskin CD-50 or equivalent.
- C. Parallel Blade Dampers: Provide parallel blade type automatic dampers for return air dampers, two-position dampers, the face section of face and bypass dampers, and where indicated on the Drawings.
- D. Opposed Blade Dampers: Provide opposed blade type dampers for volume control, exhaust and outside air dampers of a mixing section, throttling application and where indicated on Drawings.

## **2.25 DAMPER ACTUATORS**

- A. Electronic Damper Actuators
  - 1. The actuator shall be of the direct-coupled design. The fastening clamp assembly shall be of a V-bolt design with associated V-shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a V-clamp assembly of sufficient size to be directly mounted to an integral jack shaft of up to 1.05 inches when the damper is constructed in this manner. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a two (2) year manufacturer's warranty, starting from the date of installation.

2. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
3. Spring return actuators shall be provided for all outside and exhaust/relief air dampers in addition to all locations indicated on the Drawings. Spring return actuators shall be capable of both clockwise and counterclockwise spring return operation by simply changing the mounting orientation.
4. Proportional actuators shall accept a 0 - 10 VDC or 0 - 20 mA control input and provide a 2 - 10 VDC or 4 to 20 mA operating range. All actuators shall provide a 2 - 10 VDC position feedback signal and shall have an external, built-in switch to allow the reversing of direction of rotation.
5. All actuators shall not require more than 10 VA regardless of the operating voltage.
6. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in/lb torque capacity shall have a manual crank.
7. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
8. Actuators shall be Underwriters' Laboratories Standard 873 listed and Canadian Standards Association Class 481302 certified as meeting correct safety requirements and recognized industry standards.
9. Manufacturer shall be ISO9001 certified. Actuators shall be manufactured by BELIMO or equivalent.

## **2.26 CONTROL VALVES**

- A. Ball Control Valves Three Inches and Less.
  1. Two-way control valves shall be industrial quality with bronze bodies and female NPT threads. Valve bodies may also be stainless steel, titanium or nickel with operating pressure up to 2000 psi. The maximum operating differential shall be 5 psi for water.
  2. All valves shall have blowout proof stem design, glass-reinforced Teflon thrust seal washer and stuffing box ring with minimum 600 psi rating. Stem packing gland screw shall be adjustable for wear.
  3. Standard chromium plated stainless steel ball and stem, shall be rated at a minimum of 600 psi WOG (water-oil-gas), cold, non-shock, and 150 psi for saturated steam service. All valves shall be provided with reinforced Teflon seats.
  4. Belimo, Bray, or equivalent.
- B. Two- and Three-Way Globe Control Valves Two Inches and Less.
  1. Valves 1/2" through 2" shall be bronze, screw type, and shall be rated at 250 psi maximum working pressure for water and steam.

2. Valve stems shall be stainless steel, highly polished, corrosion-resistant, alloy to decrease friction and increase response. Valve plugs shall be brass and guided to ensure perfect seating.
  3. Stem packing shall be spring loaded EP V-rings for water applications and Teflon V-rings for steam applications to eliminate leakage around the stem and ensure a minimum amount of stem friction. Stem lift shall be 1/2" to 3/4".
  4. Flow type shall be equal percentage for water. The maximum operating differential shall be 5 psi for water.
  5. Composition discs shall be replaceable and provide tight shutoff.
  6. Belimo, Bray, or equivalent.
- C. Two- and Three-Way Globe Control Valves Greater than Two Inches.
1. Valves 2-1/2" through 6" shall be cast iron flanged, and rated at 125 psi maximum working pressure. The maximum working temperature shall be 300 deg F/149 deg C.
  2. Valve plug stems shall be stainless steel, highly polished, corrosion-resistant, alloy to decrease friction and increase response. Valve plugs shall be brass and guided to ensure perfect seating. Stem packing shall be Teflon, spring loaded EP V-rings to eliminate water leakage around the stem and ensure a minimum amount of stem friction. Lift shall be 3/4" to 1-1/2".
  3. Flow type shall be equal percentage. The maximum recommended differential shall be 5 psi. Composition discs shall be replaceable and provide tight shutoff.
  4. Belimo, Bray, or equivalent.
- D. Control Butterfly Valves
1. Valve body shall be of the full lug-wafer style, drilled and tapped for isolation and removal of downstream piping. Flanges shall meet ANSI 125 and 150 standards. The body shall feature an extended neck allowing for sufficient clearance for flanges and piping insulation. The cast-in top plate shall allow for direct mounting of all actuators.
  2. The disc and hub edge shall be rounded and hand polished to a 32 AARH or better finish to protect seats from damage and to reduce frictional torque. The disc shall have a full 360 degree concentric seating, minimum flow restriction and self-locking stainless steel disc to stem screws for quick and easy disassembly. A torque plug shall provide a positive leak-proof connection of the disc to the stem.
  3. Valves shall feature a single, through-shaft design for high strength and positive disc control.
  4. The seat shall be heavy duty with molded-in O-rings creating a positive seal between flange face and valve body. No gaskets shall be required between the valve and flange faces. The resilient seat shall provide a bubble-tight shutoff in either direction with the disc closed. Seat design shall isolate the body and stem from the flowing media. The seat shall not be bonded to the valve body and shall be easily replaceable in the field.
  5. The primary stem seals shall be formed by preloaded contact of the disc hub with flatted seat surfaces. The secondary stem seal shall be formed by an engineered interference fit (stem diameter larger than stem passage hole) of the stem through the seat. An internal bi-directional stem seal, located in the upper journal, shall be self-adjusting and support full vacuum and pressure to prevent contamination of the stem area and act as a tertiary seal to line pressure.



6. The top bushing, located in the upper journal, shall be non-corrosive and heavy duty to absorb actuator side thrust. Upper and lower non-wetted, metal inboard stem bearings shall be isolated from the flow media.
7. All valves are factory tested to 10 percent of specified pressure rating. The lugged version is rated for 50 psi dead-end service for removal of downstream piping.
8. Belimo, Bray, or equivalent.

## **2.27 CONTROL VALVE ACTUATORS**

### **A. Electronic Globe and Ball Valve Actuators**

1. Ball valves actuator shall be fully modulating using 2-10 VDC or 4-20 mA DC, floating point, two-position spring return as indicated in the control sequence. Fail safe, where specified, shall require mechanical spring return. The actuator shall be positive positioning, responding to a 2-10 VDC or 4-20 mA signal (with the addition of a 500 ohm resistor). There shall be a visual valve position indicator and an actuator generated 2-10 VDC valve position output signal for electronic feedback to the controller. The actuator shall have two auxiliary contacts. Power shall be 24 VAC unless indicated otherwise on the Drawings and shall not exceed 8 watts at 24 VAC. A 3-foot cable shall be provided for easy installation to an electrical junction box. The actuator shall provide minimum torque required for proper valve close-off, with an approximate running time of two (2) minutes for full rotation. The actuator shall be designed with current limiting motor protection. (End of travel switches and magnetic clutches are not acceptable.) A release button on the actuator shall be provided to allow for manual override, except when utilizing spring return actuators.
2. Ball Valves: All actuators shall be UL listed. The manufacturer shall warranty all the actuators and valve assemblies for a period of two (2) years from date of installation.
3. The actuators and valves shall be factory mounted and tested and supplied. Belimo, Bray, or equivalent.

### **B. Electronic Butterfly Valve Actuators**

1. Actuators shall have a single phase permanent split-capacitor reversible motor with 120 VAC power. The motor shall contain a built-in UL approved automatic reset thermal overload protector embedded in the motor windings. Actuators shall be designed for butterfly valves or ball valves. Use of modified damper type actuators shall not be accepted.
2. All travel switches shall be single pole, double throw, form C type rated for 10 A at 125 VAC. Travel limit switches shall limit the actuator in both the open and closed position.
3. Mechanical stainless steel travel stops shall be located outside the actuator for ease of adjustment and contain stainless steel lock nuts to hold the travel stops in place.
4. All units shall be equipped with an aluminum manual override hand wheel to rotate the valve without electrical power and disengage power if power is still applied to the valve. The override assembly shall ensure positive and fast manual operating without the use of extra tools.
5. The actuator enclosure shall be certified to UL, CSA, & CE waterproof standards NEMA 4.

6. Modulating actuators shall be positive positioning, responding to a 4-20 mA or 0-10VDC signal with a modulating 4-20 mA output from the valve indicating actual valve position.
7. Provide open and closed end switches for status feedback on all two-position valves.
8. The actuators and valves shall be factory mounted and tested and supplied. Belimo, Bray, or equivalent.

## **2.28 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING**

- A. Provide interlock wiring between supply and exhaust fans, electrical wiring for relays (including power feed) for temperature and pressure indication. Provide interlock wiring between refrigeration machines, pumps and condensing equipment as required for the specified sequence of operation and the refrigeration system integral controller(s). Do not provide interlock wiring if a dedicated digital output has been specified for the equipment or the sequence of operation requires independent start/stop.
- B. Provide power wiring, conduit and connections for low temperature thermostats, high temperature thermostats, alarms, flow switches, actuating devices for temperature, humidity, pressure and flow indication, point resets and user disconnect switches for electric heating, appliances controlled by the FMS.
- C. Provide all other wiring required for the complete operation of the specified systems including control power wiring not expressly stated to be provided by Division 26.
- D. Install all wiring raceway systems complying with the requirements of the National Electrical Code and Division 26. All installations shall be installed in EMT.
- E. FMS Network Communication Requirements
  1. Wired network communication shall be via channels consisting of communications wire installed in a 3/4" EMT.
  2. Telephone lines, where required as a remote communication source, shall utilize voice band, non-switched, private line channels consistent with Bell Systems Technical Reference Publication 41001 and shall be four-wire unconditioned 3002 channels. The modems shall have 25 pin EIA connectors and RS-232C interface.
  3. Communication conduits and wiring shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.
  4. All shields shall be ground (earth ground) at one point only, to eliminate ground loops.
  5. There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, all communication wiring and signal wiring shall be run using separate twisted shielded pairs (24 AWG) with the shields grounded in accordance with the manufacturer's wiring practices.
- F. Power and Communication Wiring Transient Protection
  1. The control manufacturers shall submit catalog data sheets providing evidence that all FMS products offered by the manufacturer are tested and comply with the standard for Transient Surge withstand capabilities for electrical devices ANSI C62.41, IEEE-587-1980, Categories A and B. Such testing shall have included power and communication trunk wiring. Compliance with IEEE-587 shall imply

conformance with IEEE-472 transient standards based on the stated position of ANSI and IEEE regarding applicability of the rated standards.

2. Communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection specifications of the General Semiconductor, Model #422E device.
3. The communications circuitry, input/output circuitry, and CUs, shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations. The manufacturer's catalog data sheet shall provide evidence of conformance with this requirement. Systems not complying with this requirement shall provide equivalent protection external to the FMS controller. Protection shall be provided for the individual communications and input/output terminations for each FMS controller. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.

#### G. Input/Output Control Wiring

1. RTD wiring shall be three-wire or four-wire twisted, shielded, minimum number 22 gage.
2. Other analog inputs shall be a minimum of number 22 gage, twisted, shielded.
3. Binary control function wiring shall be a minimum of number 18 gage.
4. Analog output control functions shall be a minimum of number 22 gage, twisted, shielded.
5. Binary input wiring shall be a minimum of number 22 gage.
6. Thermistors shall be equipped with the manufacturer's calibrated lead wiring.
7. 120V control wiring shall be #14 THHN in 3/4" conduit. Provide 4 or 20 percent fill extra wire in each conduit.

#### H. Splices

1. Splices in shielded cables shall consist of terminations and the use of shielded cable couplers which maintain the integrity of the shielding. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties as specified herein.

#### I. Conduit and Fittings

1. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.
2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.
4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

## **2.29 TEMPERATURE CONTROL PANELS**

- A. Control panels shall be provided as required for mounting of system control devices as indicated on the Drawings. Panel shall be sized as required to accommodate controls with hinged door, key lock. Panel shall be constructed of metal with metal mounting backplanes. All panels shall be supplied with the same key. All panels shall be NEMA rated and UL listed. Hoffman or equivalent.

## **2.30 CARBON DIOXIDE SENSOR**

- A. The carbon dioxide sensor shall be specifically designed to generate a linear 0-10 VDC or 4-20mA signal proportional to a 0-2000ppm CO<sub>2</sub> level in the duct. The unit shall have an accuracy of +/-2% of full scale up to 1400ppm and a selectable auto-calibration mode. Sensor shall have a minimum of 5 year warranty. SENVA Sensors C02D or equivalent.

## **2.31 EQUIPMENT CONNECTIONS**

- A. Not Applicable.

## **2.32 ELECTRONIC LIQUID DIFFERENTIAL PRESSURE SENSOR**

- A. Electronic differential pressure transmitter shall be designed to measure the differential liquid pressure as indicated on the Drawings or as required. Liquid connection shall be 1/4" NPT and the enclosure shall be NEMA 4 with 1/2" conduit knockouts. The output shall be a two wire 4-20 mA loop powered device with an input range as indicated in the Drawings but not more than twice the actual measure variable. The accuracy including linearity, hysteresis and repeatability shall be less than or equal to  $\pm 0.25\%$  of full scale. Setra Model C230 or equivalent.

## **2.33 ELECTRONIC LIQUID PRESSURE SENSOR**

- A. Electronic pressure transmitter shall be designed to measure the liquid gauge pressure as indicated on the Drawings or as required. Liquid connection shall be 1/8" NPT. The unit shall have an accuracy of  $\pm 0.13\%$  of full scale. The unit shall have stainless steel media. Setra Model C206 or equivalent.

## **2.34 INDOOR STATIC AIR PROBE**

- A. Indoor static air probes shall be provided for each indoor air pressure measurement location. They shall be flush mounted with a concealed connection. They shall be constructed of 10 gage aluminum with a 1/8" coupling for output signal connection. Air Monitor S.A.P. or equivalent.

## **2.35 BOILER REMOTE SHUTDOWN SWITCH**

- A. The emergency shutdown switch or circuit breaker must be sufficient to disconnect all power to the burner controls. It shall be constructed in a manner that safeguards it against tampering. The switch and installation shall comply with the National Electric Code, NFPA No. 70 and ASME CSD-1 CE-110.

## **2.36 ELECTRONIC HVAC LIQUID FLOWMETER**

- A. Insertion Electromagnetic Type
  - 1. The flowmeter shall be of the insertion electromagnetic type which penetrates into the line. The flowmeter shall be furnished complete with a flow transmitter which supplies a 4-20 mA or 0-10 VDC signal for flow. Meter shall have an accuracy of no less than 1% of the actual reading over the range of the meter. Meter shall include all necessary equipment to allow the flow meter to be inserted or removed without draining the system. Flow meter shall be installed

within the manufacturer's required straight pipe lengths for accuracy. If the location of the insertion meter cannot meet these requirements, then the Inline Electromagnetic Type meter shall be used. Flow meter shall be Onicon F-3500 or equivalent.

B. Inline Electromagnetic Type

1. The flowmeter shall be of the inline electromagnetic type which installs into the line. The flowmeter shall be furnished complete with a flow transmitter which supplies a 4-20 mA or 0-10 VDC signal for flow and remote digital display. Meter shall have an accuracy of no less than 1% of the actual reading over the range of the meter. Meter shall be 24 VAC powered. Meter shall include all necessary gaskets required for installation into the system. Flow meter shall be installed within the manufacturer's required straight pipe lengths for accuracy. Flow meter shall be Onicon F-3200 or equivalent.

### 2.37 BTU METER

- A. The BTU system shall be furnished complete with BTU meter, flow meter, temperature sensors, stainless steel thermowells, hot tap installation kit (as required), valves, couplings, etc. BTU meter shall be Onicon System-10 or equivalent.
- B. The BTU meter shall have a BTU display on the front of the panel. The BTU meter shall output the following signals to the FMS through a direct FMS network communication connection: Total BTU value, BTU Rate, Total Flow, Flow Rate, Supply Temperature, and Return Temperature. **The BTU shall output the following 4-20 mA signals to a third party metering system: BTU Rate, Flow Rate, Supply Temperature, and Return Temperature.** For meters which are bi-directional, the meter shall output these signals for each direction. The unit shall be UL listed.
- C. The flowmeter shall be of the insertion electromagnetic type which penetrates into the line. The flowmeter shall be furnished complete with a flow transmitter which supplies a 4-20 mA or 0-10 VDC signal for flow. Meter shall have an accuracy of no less than 1% of the actual reading over the range of the meter. Meter shall include all necessary equipment to allow the flow meter to be inserted or removed without draining the system. Flow meter shall be installed within the manufacturer's required straight pipe lengths for accuracy. If the location of the insertion meter cannot meet these requirements, then the Inline Electromagnetic Type meter shall be used. Flow meter shall be Onicon F-3500 or equivalent.

### 2.38 DOMESTIC WATER SUB-METER

- A. The domestic water/irrigation flow meters shall include a supply flow sensor/transmitter, supply pressure sensors/transmitters, strainer, and wells as specified below. The meter shall have a local readout of flow. The meter and transmitters shall utilize an input power of 24 VDC and shall provide a pulse output of totalized flow and a 4-20mA output signal for instantaneous flow and pressure. The meter and transmitters shall be suitable for operation in a mechanical room atmosphere in a 32 to 185 degrees F range. The meter and transmitters shall indicate the latest factory calibration and shall be tagged with a brass tag indicating service, building number, and calibration range. All transmitter enclosures shall be NEMA 4 with two 3/4" electrical hubs with plugs.
- B. The flow sensor shall be an inline turbine type flow meter indicating flow in GPM. The maximum pressure drop across reduced-size meter assembly at maximum design flow shall be 1.8 psi. The flow sensor shall have an accuracy of +/- 1.5% of flow across the full range for the given pipe size. The meter shall operate over the temperature range of 40 to 100 degrees F and a pressure range of 0 to 100 psig. The meter housing shall

be cast bronze with all internal pieces made of durable material such as thermoplastic or stainless steel. All bearings shall be self-lubricating. The transmitter shall have both an instantaneous flow and totalized flow output. A local totalization display shall be provided indicating instantaneous flow in GPM and totalized flow in gallons. The flow sensor shall be furnished with a strainer on the utility side of the meter. The strainer shall be provided so as to provide ease of maintenance. Flow sensor and transmitter shall be Turbo Badger Meter or prior approved equivalent.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. All devices, conduit, wiring, etc., shall be installed in a neat professional manner by skilled persons.
  - 1. The installation of all aspects of the system shall comply with all applicable codes and regulations and with Division 26 Specifications.
  - 2. The installation of all materials shall be in accordance with the published manufacturer's recommendations without exception. If for some reason a particular component cannot be installed in compliance with these recommendations, the Contractor shall advise the Engineer of the situation.
  - 3. Where miscellaneous materials are required to complete an installation, i.e., isolation valves for pressure switches, wall switches for an exhaust fan control circuit, etc.; the materials shall be supplied as defined in the relevant Section of these Specifications. For example, Section 23 0523 specifies valve requirements, and Division 26 specifies electrical products and requirements.
  - 4. Coordinate with other trades where installation of a particular component requires other trades to be involved. Installation coordination includes location the correct placement of thermowells, flow switches, dampers, control valves, control power circuits, etc. Care must be exercised to identify locations that meet the requirements of the manufacturer including upstream and downstream distances, pressures, temperatures, etc.

### **3.02 PRIMARY OPERATORS STATIONS**

- A. The new primary operator workstation[s] hardware and software shall be installed at a location coordinated with the Owner or as indicated on the Drawings.
- B. User Access
  - 1. The Owner shall be interviewed and all desired passwords and password levels shall be installed at all workstations.
- C. Reports
  - 1. The Owner shall be interviewed and all reports desired shall be completely configured including correct formatting, delivery frequency, etc.
- D. Dynamic Color Graphic Displays
  - 1. All color graphic slides shall be developed to the satisfaction of the Owner. The slides shall include all realtime point assignments, user interactive points, and realtime alarm information. At a minimum, the following graphic slides shall be developed:
    - a. A graphic shall be provided for each temperature zone of each floor. This graphic shall be a "Zoom" view of the selected temperature zone of the respective floor plan. All information displayed on the building floor plan relative to any particular temperature zone and all color coding of the temperature zone shall be the same as was provided for the floor plan

graphics. "Pick" windows shall be provide on these graphics to permit the operator to view specific mechanical system graphics relative to the respective floor plan.

- b. Separate graphics shall be provided for all mechanical equipment serving the respective building or zone. This includes all central station units, boiler plant, air compressors, central plant, etc. Mechanical system graphics shall be displayed complete with all real time data relevant to the equipment being displayed including temperatures, flow rates, positions, etc.
2. Database Save/Restore/Backup
    - a. After all FMS controller software, operator workstation software, and graphic slides have been developed, two (2) complete backup sets of this software shall be delivered to the Architect for archiving.

### **3.03 FMS CONTROLLERS**

#### **A. General**

1. All FMS controllers shall be installed in accordance with manufacturer's instructions. Power shall be provided to each FMS controller in accordance with Division 26 and all applicable codes.
2. All FMS controllers shall be installed in an enclosure that provides protection from the environment and is adequately ventilated to protect against excessive temperature exposure.

#### **B. Input/Output**

1. All points shown on the control diagrams or required to meet the Sequence of Operation shall be connected to the respective FMS controller in accordance with the manufacturer's instructions. Each point shall be checked for voltage, short circuit, etc., prior to termination to the FMS controller to prevent potential damage to the controller.

#### **C. Software Requirements**

##### **1. General**

- a. All sequences of operation listed on the Drawings are to be implemented as they relate to the points shown on the Drawings. Any additional points required to meet the sequence of operation shall be provided whether indicated on the Drawings or not. In addition to the sequences of operation indicated on the Drawings, the following general sequences shall be implemented.

##### **2. Optimal Start**

- a. Develop software to start all equipment based on the individual zone temperature, outside air temperature, heating/cooling capacity in degree Fahrenheit/hour of the equipment serving that zone and the previous optimal start time in establishing the optimal start time for the following day. The optimal start program shall work in conjunction with the scheduled start time to minimize energy consumption.
- b. In no case shall the optimal start routine keep the AHU from running after the occupancy start time identified as the scheduled start time.
- c. The AHUs shall run continuously until the scheduled stop time. No optimal stop program time shall be provided.

3. Run Time Totalization
  - a. All digital input and output points shall be setup to accumulate run time information. Maximum run time limits shall be defined and shall automatically issue a printed message as defined by the Owner.
4. Alarms
  - a. All analog input points shall have upper and lower limits established and alarms shall be generated in the event these limits are exceeded. The Contractor shall define reasonable limits for these alarm points. Digital inputs shall be compared to the associated digital outputs (fan start/stop and status) and alarms shall be issued if the commanded position is inconsistent with the actual condition, after a start delay timer. All alarms shall be directed to the primary operator workstations and shall be archived on the hard drives.
5. Minimum Runtimes
  - a. All digital output points shall have a minimum runtime of five (5) minutes to prevent accidental short cycling.
6. Staggered Starts
  - a. All digital outputs shall have staggered start times of at least 30 seconds to minimize demand spikes.
7. Trend Analysis (DDC Controller and all attached TCUs and ASCs)
  - a. In order to verify and document satisfactory system operation, at a minimum, all trend logs defined in Appendix A shall be developed and implemented. As work of this Section, all control loops, inter-start delays, minimum and maximum run times, etc., shall be tuned to meet the constraints listed in Appendix A.
  - b. All analog and digital trend logs shall be printed in text form with a graph of the corresponding trend data attached as the cover to the text trend data.
  - c. All trend graphs shall be printed, maximized in landscape form, on one 8.5" x 11" sheet of paper. Graphs requiring the display of more points than can be reasonable displayed on one graph may be graphed on separate sheet, however, the time stamps of each graph must match exactly so that data from multiple graphs may be compared.
  - d. Each analog graph shall include an "x" time/date axis scale and one or two "y" axis scales as required to adequately display the trend data. Each digital trend may be of any style and developed such that overlapping digital sequences are obvious to the viewer. Each axis shall be labeled and scaled. Axis scaling shall be set to clearly show the desired control response and required trend duration. A legend shall be provided clearly defining each trend line. Graphs may be color or black and white, however, black and white graphs must use patterns making the information clearly understandable. The time and date of displayed data shall be provided on both the text trend log printout and the graph printout. Examples of the minimum level of detail that will be required for all trend graphs are included in Appendix B of this Section.
  - e. If trend logs are printed and graphed using cryptic systems point names, a legend shall be provided with each trend to make the translation of the trended points easily understood.



- f. All required trends, graphs, and completed point verification forms shall be compiled into a project closeout notebook(s) with tabs indicating the system being trended. For example, point verification forms for AHU-1, the supply air temperature control loop for AHU-1, the static pressure control loop for AHU-1, and the mixed air temperature control loop for AHU-1 shall be included under a tab labeled AHU-1. Zone trend data may be grouped under logical headings by AHU, floor, etc. A complete detailed index of all trend data and graphs shall be included in the front of the notebook(s). A page shall also be included in the front of the notebook identifying who performed which trend log.
- g. The completed closeout notebook(s) shall be provided as part of the close out documentation required in Section 23 0500. Acceptance of the system will not be given until this requirement is met.

### **3.04 TERMINAL UNIT CONTROLLER**

#### **A. General**

- 1. A maximum of one (1) TUC shall be installed on each piece of equipment (i.e., fan coil, VAV box, etc.,) and a maximum of one piece of equipment shall be connected to one (1) TUC.
- 2. Power shall be provided to each TUC and installed in accordance with Division 26 and all applicable codes.
- 3. All FMS controllers shall be installed in an enclosure that provides protection from the environment and is adequately ventilated to protect against excessive temperature exposure.

#### **B. Input/Output**

- 1. All points listed on the Drawings or required to meet the sequence of operations shall be connected to the respective TUC in accordance with the manufacturer's instructions. Each point shall be checked for voltage, short circuit, etc., prior to termination to the FMS controller to prevent potential damage to the controller.

### **3.05 OPERATOR INTERFACE PANELS**

- A. The operator interface panel shall be installed on or near the FMS control panel or as indicated on the Drawings. The panel shall be connected to the FMS network and programmed to allow the functionality described in Section 2.6 of this Specification.
- B. The Owner shall be interviewed and all desired passwords and password levels shall be installed at the interface panel.

### **3.06 NETWORKING/COMMUNICATIONS**

#### **A. General**

- 1. All LANs shall be installed in a manner recommended by the manufacturer, owner's representatives, based on the environment, communications speed requirements, and distance. All LAN media shall be installed in a manner that provides protection from physical damage and interference from RF or other electrical sources.

#### **B. Primary Local Area Network (LAN)**

- 1. The primary LAN shall be installed in accordance with all Division 26 communication specification requirements. The Contractor shall provide all conduit, wire, routers, hubs, etc., unless otherwise stated on the Drawings for a complete and operating FMS ETHERNET® communication network. All operator workstations and FMS controllers/routers shall be connected to the LAN.

- C. FMS Controller Local Area Network (LAN)
  - 1. The controller LAN shall be installed with materials and procedures that comply with the requirements of the FMS equipment manufacturer. In general, the conductors are to be a 22 gage, low capacitance, and twisted pair. All FMS controllers (if not connected to the primary LAN) and ACS controllers shall be connected to the LAN.
- D. Sub-Controller Local Area Network (LAN)
  - 1. The sub-controller LAN shall be installed with materials and procedures that comply with the requirements of the FMS equipment manufacturer. In general, the conductors are to be a 22 gage, low capacitance, twisted pair. All TU controllers shall be connected to the LAN.

### **3.07 DUCT STATIC PRESSURE STATION**

- A. Ensure that the direction of flow is observed when installing the probe to prevent measurement of total pressure. The connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. Connections from the "HI" pressure port to the differential pressure transducer shall be 1/4" plastic tubing which shall not extend for more than ten feet. Pressure stations shall be installed 2/3 the distance down the duct of all major branch ducts or as indicated on the Drawings.

### **3.08 OUTSIDE AIR STATIC PRESSURE PROBE**

- A. Outside air static pressure probe must be installed and piped according to manufacturer's instructions to ensure accuracy of the static pressure reading and eliminate the effects of condensation in the sensing lines. Coordinate installation of probe with the necessary trades for proper sealing of all roof penetrations.

### **3.09 ELECTRONIC DIFFERENTIAL PRESSURE TRANSMITTER**

- A. All differential pressure transmitters shall be installed within ten feet of the pressure sensing point. The transmitters shall be installed in a NEMA 1 housing for interior conditioned spaces and in NEMA 3R housings for outside or unconditioned spaces. The transmitters and housings shall be rigidly supported to prevent vibration and shall never be mounted to ductwork or piping. Access to the transmitter shall be provided.

### **3.10 ELECTRONIC TEMPERATURE ELEMENT AND TRANSMITTER**

- A. Space temperature transmitters shall be installed 44" A.F.F. to the center of transmitter unless otherwise noted on the architectural drawings or specifications.
- B. All temperature sensors installed in liquid lines, tanks, etc., shall be installed in stainless steel thermowells. The thermowells shall be supplied to the mechanical contractor for installation under other Sections of the Specification. A thermo-conductive paste shall be applied between the sensing element and the thermowell.
- C. Outdoor air temperature elements shall be installed in a location that is continuously shaded and not effected by heat generating equipment or equipment intakes or discharges. The element shall be installed under a sun shield and high enough to avoid damage from vandalism.
- D. Duct point temperature elements shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. Care must be taken to avoid direct contact between the temperature element and any heat transfer surface such as a coil.

- E. Duct averaging elements shall be installed with the same requirements as for the temperature point elements; however; the averaging elements shall be extended across the entire duct area in a zigzag pattern. Special clips shall be used to secure the elements at turns to prevent chafing of the elements. Where the elements pass through the duct, plastic tubing or similar protection shall be installed on the elements to prevent damage to the elements from vibration.

### **3.11 AIR FLOW STATION AND TRANSMITTER**

#### **A. Pitot Tube Air Flow Element and Transmitter**

1. Ensure that the direction of flow is observed when installing the station in the ductwork. The station shall be installed in accordance with manufacturer's published up- and down-stream duct length requirements.
2. All connection points shall be secured. Connections from the "HI" and "LO" pressure ports to the air flow transmitter shall be 1/4-inch plastic tubing which shall not extend for more than ten feet.
3. The flow transmitter shall be wall mounted with the display at 60" A.F.F. The flow transmitter shall be completely setup to meet the actual field measurement conditions and output CFM. Provide 24 VAC power for transmitter.

#### **B. Thermal Anemometer Air Flow Station**

1. Ensure that the direction of flow is observed when installing the station in the ductwork. The station shall be installed in accordance with the manufacturer's published up- and down-stream duct length requirements. If a suitable location for the flow station cannot be achieved, the Contractor shall consult with the engineer and manufacturer with possible alternative locations.
2. All connection points shall be secured. Provide all power requirements for the unit and connect to the FMS.

### **3.12 ELECTRONIC HUMIDITY TRANSMITTER**

- A. Outdoor humidity transmitters shall be installed in a location not affected by equipments that might generate humidity or temperature effects. The transmitter shall be installed where direct moisture (rain) cannot contact the device.
- B. Duct point humidity elements shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. The sensing element shall be located at least ten feet downstream of any coil, humidifier, or dehumidified.
- C. Space humidity transmitters shall be installed at 60" A.F.F. If a setpoint adjustment is provided on the unit, the unit shall be installed at 48" A.F.F. unless otherwise specified on the plans.

### **3.13 CURRENT TRANSDUCERS**

- A. Current transducers shall be installed on one hot leg of either single or three phase and after the local disconnect. The transducers shall be located in the motor starter housing or motor control center and secured to the structure using sheet metal screws.

### **3.14 CURRENT SENSING SWITCH**

- A. Current switches shall be installed in one leg of three phase circuits and the hot leg of single phase circuits and in all cases, after the local disconnect. The switches shall be adjusted to close at approximately 10% of the attached loads full load amps.

### **3.15 AIR DIFFERENTIAL PRESSURE SWITCHES**

- A. Differential pressure switches shall be connected to pitot tube pickup probes pointing into the air stream on both sides of the process variable. Connection between the switch and the pitot tubes shall be 1/4" hard copper. The switches shall be adjusted to close at approximately 25% of the fans maximum speed or at the dirty filter pressure differential.

### **3.16 ELECTRIC LINE VOLTAGE THERMOSTAT**

- A. Where thermostats are to be mounted remotely from the controlled device, all conductors shall be installed in a metallic raceway and the thermostat shall be mounted on a junction box. Mount the thermostat 48" A.F.F. unless otherwise specified on plans.

### **3.17 ELECTRIC FLOW SWITCH**

- A. Flow switches shall be installed in a Thread-O-Let installed under Sections of the Specification. The paddle of the flow switch shall be selected and the spring adjustment shall be carefully set to provide good switching between flow and no flow conditions. Ensure that the flow direction of the device matches the actual flow direction.

### **3.18 ELECTRIC LOW LIMIT (FREEZESTAT)**

- A. Low limit thermostats shall be installed with the averaging element extended across the entire duct area in a zigzag pattern. Special clips shall be used to secure the element at turns to prevent chafing of the element. Where the element pass through the duct, plastic tubing or similar protection shall be installed on the element to prevent damage to the element from vibration. The thermostat setpoint shall be set as indicated and the circuit shall be tested to ensure actions as required.

### **3.19 LIQUID DIFFERENTIAL PRESSURE SWITCH**

- A. Differential pressure switches shall be connected to pressure taps installed on the piping under other Sections of the Specification. The connections shall be 1/4" hard copper complete with isolation valves on both lines. The switch shall be supported either by mounting on a wall or on a frame constructed from Unistrut. The switch setpoint and differential shall be set as necessary to provide good switching between pressure and no pressure conditions.

### **3.20 CONTROL RELAYS**

- A. Control relays shall be field or panel mounted as indicated on the Drawings. If a relay is field mounted it will be installed in a NEMA I housing.
- B. Control relays shall be installed in bases and the based mounted on a DIN rail. All accessories including end clips, jumpers, etc., shall be provided. All wiring shall be labeled. Multiple conductors shall be bundled and run by classification in plastic wireways. Relays shall be labeled as indicated in the shop drawings for ease in troubleshooting.

### **3.21 CONTROL TRANSFORMERS**

- A. Control transformers shall be field mounted using a plate to mount on the associated junction box or panel using a foot-style mounting. Locations shall be as identified on the Drawings or as determined by field requirements. A phenolic label on each transformer shall identify the power source by breaker panel and circuit. Fusing of the primary and secondary sides and sizing shall be as defined by the NEC. Provide means of local disconnect for transformer to allow removal.

### **3.22 ELECTRIC-PRESSURE SWITCHES**

- A. Switches shall be panel mounted unless otherwise indicated. Pneumatic connections within the panel may be 1/4" plastic tubing. Switches shall be identified with a phenolic label for ease in troubleshooting.

### **3.23 PNEUMATIC PRESSURE GAUGES**

- A. Pressure gauges shall be installed in all locations indicated on the Drawings. Gauges shall be oriented so that they can be easily seen and serviced.

### **3.24 AUTOMATIC DAMPERS**

- A. All automatic control dampers shall be installed under Section 23 3000.

### **3.25 DAMPER ACTUATORS**

- A. Electronic Damper Actuators
  - 1. Damper actuators shall be mounted on the damper jack shaft or shaft extender using a V-clamp. The actuator shall then be anchored to the ductwork housing the damper. All power requirements for the actuators shall be supplied under this Section of the Specification.

### **3.26 CONTROL VALVES**

- A. The valves shall be installed by the mechanical contractor under other Sections of the Specification.

### **3.27 CONTROL VALVE ACTUATORS**

- A. Electronic Valve Actuators
  - 1. Valve actuators shall be supplied factory assembled with the respective control valve.

### **3.28 ELECTRIC TO PNEUMATIC (EP) TRANSDUCERS**

- A. Transducers shall be installed in control panels and shall be identified with a phenolic label for ease in troubleshooting. Connection of main and branch signals shall be 1/4" plastic tubing from the device to panel bulkhead fittings. An inline disposable filter shall be installed in the main air line to each transducer.

### **3.29 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING**

- A. Comply with all Division 26 installation requirements.
- B. Install low voltage power in conduit in the following locations regardless of local building code allowances otherwise.
  - 1. Mechanical rooms.
  - 2. Electrical rooms.
  - 3. Open areas where the wiring will be exposed to view or tampering.
  - 4. Hard ceilings and walls.
- C. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.
- D. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

- E. All wire-to-device connections shall be made at terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- F. Plug or cap all unused conduit openings and stubups. Do not use caulking compound.
- G. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.
- H. Set conduits as follows:
  - 1. Expanding silicone firestop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.
  - 2. Oakum and lead, sealed watertight penetration through outside foundation walls.
- I. Cap open ends of conduits until conductors are installed.
- J. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18" and maximum length of 36" shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
- K. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.
- L. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

### **3.30 TEMPERATURE CONTROL PANELS**

- A. All tubing and wiring shall be clearly labeled with Brady-type marker labels and run to numbered terminal strips or tubing manifolds these wire, tube, and terminal numbers shall be shown on all control diagrams. Wires and tubes shall be labeled at all connection points.
- B. All control devices shall be labeled with engraved phenolic tags showing device number and name, model number, setpoint, range, action, etc. Panel Face indicators shall be labeled with engraved phenolic tags identifying what is shown on indicator.
- C. Hard tubing shall be brought into the panel using bulkhead fittings; tubing within the panel may be plastic.
- D. Electronic digital indicators shall be provided where shown on the Drawings. Indicators shall be LED or LCD loop powered type and fully compatible with the associated transmitter and matched to the range of the transmitters. Indicators shall be flush mounted on the control panel door.
- E. Terminal strips shall be provided in all control panels for the termination of all field wiring. An additional 25% but not more than 50 terminal strips shall be provided for future use. Terminal strips shall be rated for no less than 300 VAC, 1/4" in width, track mounted, and a slot provided for labeling strips. All terminals shall be labeled as shown on the as-built drawing. No more than two conductors shall be terminated on a single terminal.

- F. Control transformers shall be provided where shown or where required to meet the sequence of operation. Control transformers shall be provided with a phenolic label identifying the source of power.
- G. Control panel front mounted pilot lights shall be provided where shown on the Drawings or electrical ladder diagrams. Lights shall have replaceable bulbs and lenses and shall incorporate a "push-to-test" feature. Voltage rating of pilot light may be full load voltage or dropped across a line resistor. In no case may the voltage to pilot lights exceed 120 VAC.
- H. Control panels shall have wire ways installed to group all wiring within a panel. Panels shall be manufactured in a professional manner to the satisfaction on the Owner and Engineer.

### **3.31 CARBON DIOXIDE SENSOR**

- A. Duct carbon dioxide shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. The sensing element shall be located at least ten feet downstream of any coil, humidifier, or dehumidified.
- B. Space carbon dioxide sensors shall be installed at 48" A.F.F.

### **3.32 EQUIPMENT CONNECTIONS**

- A. FMS Class II field wiring for all non-control device applications shall be installed under this Section of the Specification. This includes equipment such as VFDs, chillers, boilers, packaged air handling equipment, etc., that may have point types include status or alarm monitored from an equipment supplier Class C contact or analog control signals to equipment, etc.

### **3.33 ELECTRONIC LIQUID DIFFERENTIAL PRESSURE TRANSMITTER**

- A. All liquid differential pressure transmitters shall be installed within ten feet of the pressure sensing points. The transmitter shall be rigidly supported to prevent vibration and shall never be mounted to ductwork or piping. The piping for the sensing points shall include isolation valves such that the transmitter can be removed without having to shut down the liquid system. Access to the transmitter shall be provided.

### **3.34 ELECTRONIC LIQUID PRESSURE TRANSMITTER**

- A. All liquid pressure transmitters shall be installed within ten feet of the pressure sensing ports. The transmitter shall be rigidly supported to prevent vibration if it is not directly connected to the pipe. The piping for the sensing points shall include isolation valves such that the transmitter can be removed without having to shut down the liquid system. Access to the transmitter shall be provided.

### **3.35 INDOOR STATIC AIR PROBE**

- A. Indoor static air probes shall be mounted in the ceiling in locations indicated on the Drawings or as required.

### **3.36 BOILER REMOTE SHUTDOWN SWITCH**

- A. The manually operated remote shutdown switch or circuit breaker shall be located just outside the boiler room door and marked for easy identification. It should be installed in a location, which safeguards it against tampering. If the boiler room door is on the building exterior, the switch should be located just inside the door. If there is more than one door to the boiler room, there should be a switch located at each door.

**3.37 ELECTRONIC HVAC LIQUID FLOWMETER**

A. The flow meter/transmitter shall be installed according to the manufacturer's recommendations and tied into the FMS system.

**3.38 DOMESTIC WATER SUB-METER**

A. The sensors and transmitters shall be installed in accordance with the manufacturer's installation requirements. All inline meters shall be installed with isolation valves on both sides. A by-pass is not required. The contractor shall connect all outputs from the transmitters and meter to the FMS per the requirements of these specifications. The contractor shall provide all necessary transformers to provide power for all transmitters and meters.

**END OF SECTION 23 09 00**



## APPENDIX A

### Verification Trend Log Development and Acceptance Requirements

<b>AHU-1 TREND LOG REQUIREMENTS</b>			
<b>Trend #1 (Supply Air Temperature Control)</b>			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes during occupied mode	1 minute	SA temperature SA temperature set point Chilled water valve control signal	SA temperature $\pm 0.5^{\circ}\text{F}$ of SA temperature SP with hunting of no more than 5% of the control signal
<b>Trend #2 (Supply Air Static Pressure Control)</b>			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes during occupied mode	1 minute	SA static pressure SA static pressure set point VFD control signal	SA pressure $\pm 0.05^{\circ}\text{F}$ of SA static pressure SP with hunting of no more than 5% of the control signal
<b>Trend #3 (Mixed Air Temperature Control)</b>			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes during occupied mode	1 minute	MA temperature MA temperature set point Mixing damper control signal	MA temperature $\pm 0.5^{\circ}\text{F}$ of MA temperature SP with hunting of no more than 5% of the control signal
<b>Trend #4 (Fan Safety Test)</b>			
Trend Duration	Sample Interval	Trend Points	Required Test Sequence
N/A - Allow 2 minutes between test sequence events	1 minute	Fan commanded position Fan (VFD) status Freezestat Condition Supply air smoke detector Return air smoke detector MA damper signal	1) Fan stopped, safeties normal; 2) Fan commanded on, safeties normal; 3) Freezestat tripped; 4) Freezestat reset; 5) SA Smoke detector tripped; 6) SA smoke detector reset; 7) RA smoke detector tripped; 8) RA smoke detector reset;

<b>VAV TERMINAL UNIT TREND LOG REQUIREMENTS</b>			
<b>Trend #1 (Space Temperature Control Range Test)</b>			
Trend Duration	Sample Interval	Trend Points	Required Test Sequence
N/A - Allow full system response recovery between test sequences	1 minute	Space temperature Space temperature set point HW valve control signal Primary air control damper signal Primary air flowrate Primary air flowrate set point Primary air flowrate maximum Primary air flowrate minimum	1) Space temperature at or near set point; 2) Adjust space temperature set point 3.0°F below actual temperature; 3) Adjust space temperature set point 3.0°F above actual temperature; 4) Return space temperature set point to design condition;
<b>Trend #2 (Space Temperature Control)</b>			
Trend Duration	Sample Interval	Trend Points	Required Response
24 Hours – including transitions from unoccupied to occupied and occupied to unoccupied modes	10 minute	Space temperature Space temperature set point	Space temperature remains within $\pm 0.5^{\circ}\text{F}$ of space temperature set point with hunting of no more than 5% of the control signal for the hot water or primary air flow rates.

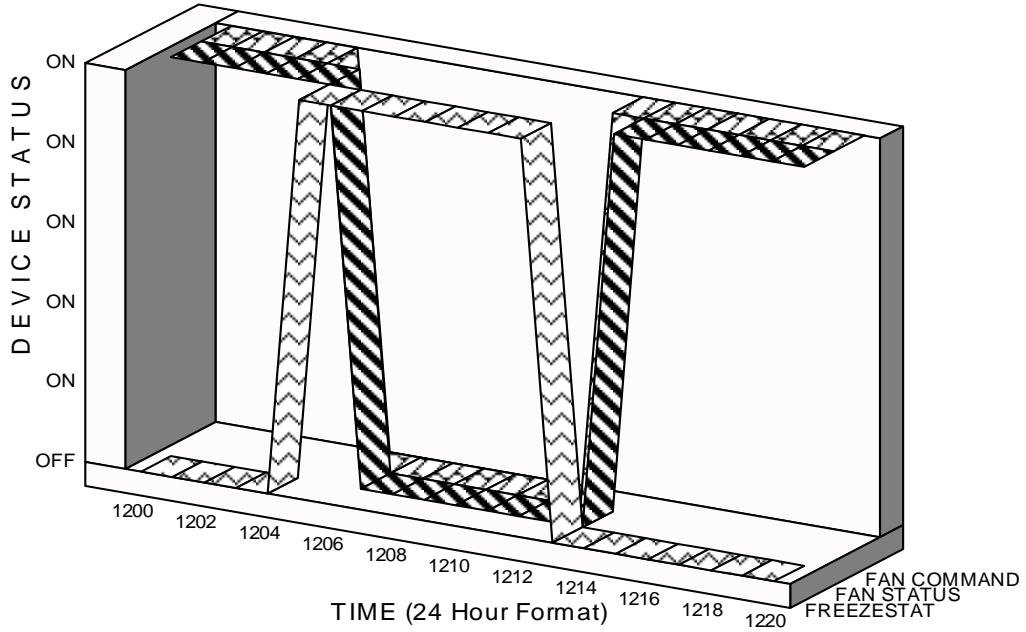
<b>SECONDARY CHILLED WATER SYSTEM TREND LOG REQUIREMENTS</b>			
<b>Trend #1 (Differential Pressure Control)</b>			
Trend Duration	Sample Interval	Trend Points	Required Response
60 minutes	1 minute	CW differential pressure CW differential pressure set point Control signal to VFD #1 Control signal to VFD #2	Differential pressure remains within $\pm 1.0$ PSID
<b>Trend #2 (Differential Pressure Setpoint Control)</b>			
Trend Duration	Sample Interval	Trend Points	Required Response
24 Hours – including transitions from unoccupied to occupied and occupied to unoccupied modes	10 minute	CW differential pressure CW differential pressure set point Maximum position of all CW valves Minimum position of all CW valves	Set point resets so that one or more of the chilled water coil valves is between 90% and 100% open with hunting of the differential pressure set point less than 1.0 PSIG
<b>Trend #2 (Pump Automatic Switchover Control Test)</b>			
Trend Duration	Sample Interval	Trend Points	Required Test Sequence
N/A - Allow full system response recovery between test sequences	1 minute	CW differential pressure CW differential pressure set point CW pump #1 commanded position CW pump #1 status CW pump #1 control signal CW pump #2 commanded position CW pump #2 status CW pump #2 control signal	1) CW pump #1 on in lead position and in control; 2) Manually shut off the VFD serving CW pump #1; 3) Repeat steps #1 & #2 with CW pump #2 as the lead pump

**APPENDIX B**

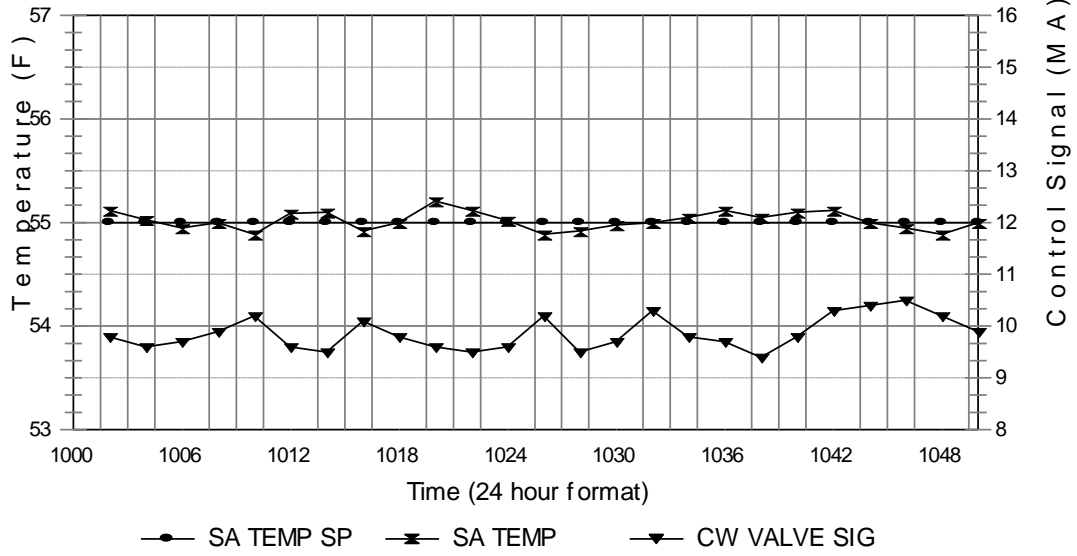
Typical Trend Graph Requirements

**AHU-1**

Fan Safety Sequence Test



## AHU-1 Supply Air Temperature Control



### APPENDIX C

#### Typical Point Verification Form

POINT VERIFICATION FOR AHU-1						
Point Description	Software Point Name	Point Type	Date Tested	Results (Pass/Fail)	Contractor Initials <sup>(1)</sup>	Inspector Initials <sup>(2)</sup>
SA Temp Sensor	AH1SATMP	AI	11/1/99	Pass	RTC	ALM
SA Static Press	AH1SASTAT	AI	11/1/99	Pass	RTC	ALM
Fan S/S	AH1SAFSS	DO	10/14/99	Pass	RTC	ALM
Fan Status	AH1SAFST	DI	10/14/99	Pass	RTC	ALM
Freezestat <sup>(3)</sup>	AH1FZ	DI	10/13/99	Pass	RTC	ALM
CW valve control	AH1CWV	AO	10/14/99	Pass	RTC	ALM

- (1) RTC is Robert T. Conbert of Acme Control Company, Inc.
- (2) ALM is Albert L. Mackey, P.E. of Zebra Commissioning Company, Inc.
- (3) Freezestat is also hard wired to stop fan in the hand or auto position. These interlocks were tested on the same day.

## **SECTION 23 21 13**

### **HEATING HOT WATER SYSTEM AND EQUIPMENT**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

##### **1.02 RELATED SECTIONS**

- A. Section 23 05 00, Common Work Requirements for HVAC.
- B. Section 23 05 04, Pipe and Pipe Fittings.
- C. Section 23 05 05, Piping Specialties.
- D. Section 23 05 23, Valves.
- E. Section 23 07 00, HVAC Insulation.
- F. Section 23 09 00, Facility Management System, for temperature control valves, meters and instrumentation.
- G. Division 26, Electrical.

#### **PART 2 PRODUCTS**

##### **2.01 PIPING**

- A. Hot water heating piping shall be black steel pipe A53 grade A or B, seamless ERW or BW, standard wall Schedule 40 through 10" diameter. Larger diameter pipe shall have wall thickness as follows:
- B. Contractor may use Type L hard drawn copper tubing, ASTM B88 for hot water piping sizes 2" and smaller. Proper insulating fittings, as specified in Section 23 0504, shall be installed to prevent electrolytic action between steel and copper piping connections.

##### **2.02 FITTINGS**

- A. Fittings for steel piping, 2" and smaller, shall be either screwed or welded. Screwed fittings shall be either Class 150, standard black malleable iron conforming to ANSI B16.3 or Class 125, standard black cast iron conforming to ANSI B16.4. Weld fittings shall be either standard weight steel butt-welding fittings conforming to ANSI B16.9 or forged steel socket-welding fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.
- B. Fittings for steel piping, 2-1/2" and larger shall be standard weight steel butt-welding fittings, conforming to ANSI B16.9.
- C. Fittings for copper piping shall be wrought copper conforming to ANSI B16.22, with 95-5 solder joints, as specified in Section 23 0504.

##### **2.03 FLANGES**

- A. Flanges for steel piping system shall be forged steel, weld neck or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5.
- B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.
- C. Where specifically required by the application, black cast iron Class 125, standard threaded plain face companion flanges may be utilized for flanged connections in threaded piping systems.

- D. Gaskets shall be 1/16" thick ring type or full face non-asbestos material suitable for the temperatures and pressure application.
- E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

#### **2.04 VALVES**

- A. Valves other than automatic control valves are specified in Section 23 0523, HVAC Valves.
- B. Automatic control valves shall be as specified in Section 23 0900, Facility Management System.

#### **2.05 HOT WATER GENERATING EQUIPMENT**

- A. Hot water boilers and associated auxiliary equipment shall be as specified on the equipment schedule on the drawings.
- B. The Contractor shall provide the services of a qualified factory-trained representative to supervise hot water boiler system start-up and instruct the Owner's operating personnel for a minimum of eight (8) hours. In addition, a full one-year service warranty, including all parts and labor shall be provided by the Contractor.

#### **2.06 PUMPS**

- A. Pumps shall be of the type and capacity listed in the Equipment Schedule. Pumps shall be selected so that the motors will not overload under any operating condition. Furnish one spare mechanical seal of each size required in conjunction with the pumps furnished under this Contract. All pumps shall have drain pans with tapped pipe connections and 3/4" drain line extended to floor drain. Pumps shall be installed so that they may be removed without the removal of the associated piping.

#### **2.07 COILS**

- A. Hot water heating coils shall be as specified in Section 23 30 00, and listed in the Mechanical Equipment Schedule.

#### **2.08 EXPANSION TANK**

- A. Expansion tank shall be of the pressurized diaphragm type as specified in Section 23 05 05 and listed on the Mechanical Equipment Schedule on the drawings.

#### **2.09 WATER TREATMENT**

- A. Water treatment system, including shot type feeders shall be furnished by the Contractor.
- B. Tanks shall be connected to the supply and return mains by means of 3/4" pipe with valves in each connection and with a 3/8" test cock on the supply connection. Tanks shall be wall or floor mounted on steel support adjacent to system pumps. The Contractor shall provide complete installation of water treatment equipment as shown on the drawings and as required by the Owner's designated Water Treatment Agency.
- C. Chemicals as required for the system startup, operational testing shall be provided by the Owner's designated Water Treatment Agency in sufficient quantities to maintain the level of chemical concentration recommended by the Water Treatment Agency and shall be included in the contract price. The exact type of chemical treatment compounds shall be determined by the Water Treatment Agency and approved by the Owner's Representative.



- D. After system acceptance by the Owner, the continuing water treatment will be the Owner's responsibility.
- E. The Owner's designated Water Treatment Agency is: Nalco, Contact Scott at (719) 659-8988.

## **2.10 FLOW MEASURING STATIONS**

- A. Furnish and install water flow measuring station and automatic flow control valves where shown on the drawings and as specified in Section 23 05 05.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Piping installation shall conform to the requirements of Section 23 05 00, Common Work Requirements for HVAC, Section 23 05 04, Pipe and Pipe Fittings. Installation of specialties shall conform to the requirements of Section 23 05 05, Piping Specialties.

### **3.02 CLEANING AND FLUSHING PIPING SYSTEMS**

- A. New heating water piping systems installed under this Contract shall be chemically cleaned of oils, greases, dirt and mill scale. The new piping system shall be inspected by the Owner's approved Water Treatment Agency to determine the appropriate cleanout procedures and recommended cleaning chemical materials.
- B. Cleaning shall be performed in strict accordance with the chemical treatment agency and manufacturer's recommendations, and shall generally consist of the following:
  - 1. Fill, flush, and drain piping systems with water to remove loose dirt and debris from the system.
  - 2. Refill piping system with cleaning compounds, diluted to recommended concentrations and circulate for required time period.
  - 3. Drain and flush system.
  - 4. Neutralize using caustic and soda ash as required when cleaning with acid compounds.
  - 5. Drain and inspect system and repeat cleaning if necessary.
- C. In conjunction with piping system cleaning, clean and inspect all strainers and suction diffusers. Remove, bypass, or otherwise protect as necessary all piping system components which may be damaged due to chemical cleaning, including filters, instrumentation gauges, flow meters, etc.
- D. After completion of chemical cleaning and flushing, the piping system shall be immediately refilled and maintained with treated water. Under no circumstances shall cleaned piping be allowed to sit empty or filled with untreated water.

### **3.03 TESTS**

- A. All piping shall be proven tight at a hydrostatic pressure of 150% of the system design operating pressure, but not less than 125 PSI. The system shall show no loss in pressure or indication of leakage at any joint or connection for a period of one (1) hour.

## **END OF SECTION**



## **SECTION 23 21 14**

### **CHILLED WATER SYSTEM AND EQUIPMENT**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Conform with applicable provisions of the General Conditions, Supplemental General Conditions and General Requirements.

##### **1.02 RELATED SECTIONS**

- A. Section 23 05 00, Common Work Requirements for HVAC.
- B. Section 23 05 04, Pipe and Pipe Fittings.
- C. Section 23 05 05, Piping Specialties.
- D. Section 23 05 23, Valves.
- E. Section 23 07 00, HVAC Insulation.
- F. Section 23 09 00, Facility Management System for temperature control valves, meters and instrumentation.
- G. Division 26, Electrical.

#### **PART 2 PRODUCTS**

##### **2.01 PIPING**

- A. Chilled water piping shall be black steel pipe ASTM A120 or A53 grade A or B, ERW or BW, standard wall Schedule 40 through 10" diameter. Larger diameter pipe shall have wall thickness as follows:
- B. Contractor may use Type L hard drawn copper tubing, ASTM B88 for chilled water piping sizes 2" and smaller. Proper insulating fittings, as specified in Section 23 0504, shall be installed to prevent electrolytic action between steel and copper piping connections.

##### **2.02 FITTINGS**

- A. Fittings for steel piping, 2" and smaller, shall be either screwed or welded. Screwed fittings shall be either Class 150, standard black malleable iron conforming to ANSI B16.3 or Class 125, standard black cast iron conforming to ANSI B16.4. Weld fittings shall be either standard weight steel butt-welding fittings conforming to ANSI B16.9 or forged steel socket-welding fittings, 2000 pound Schedule 40 conforming to ANSI B16.11.
- B. Fittings for steel piping, 2-1/2" and larger shall be standard weight steel butt-welding fittings, conforming to ANSI B16.9, as specified in Section 23 0504.
- C. Fittings for copper piping shall be wrought copper conforming to ANSI B16.22, with 95-5 solder joints, as specified in Section 23 05 04.

##### **2.03 FLANGES**

- A. Flanges for steel piping system shall be forged steel, weld neck or slip-on, 1/16" raised face Class 150 flanges conforming to ANSI B16.5.
- B. Flange connections for valves and equipment shall match the rating and drilling of the valves and equipment furnished.
- C. Where specifically required by the application, black cast iron Class 125, standard threaded plain face companion flanges may be utilized for flanged connections in threaded piping systems.

- D. Gaskets shall be 1/16" thick ring type or full face non-asbestos material suitable for the temperatures and pressure application and suitable for propylene glycol and water solution utilized in the chilled water system.
- E. Flange bolting shall be carbon steel machine bolts or studs and hex nuts, ASTM A307, Grade B.

#### **2.04 VALVES**

- A. Valves other than automatic control valves shall be specified in Section 23 0523, Valves.
- B. Automatic control valves shall be as specified in Section 23 0900, Facility Management System.

#### **2.05 PUMPS**

- A. Pumps shall be of the type and capacity listed in the Equipment Schedule, and shall be furnished with drip-proof motors. Pumps shall be selected so that the motors will not overload under any operating conditions. Furnish one spare mechanical seal of each size required in conjunction with the pumps furnished under this contract. All pumps shall have drain pans with tapped pipe connections and 3/4" drain line extended to floor drain. Pumps shall be installed so that they may be removed without the removal of the associated piping.
- B. Pump packing, seals, and gaskets shall be suitable for propylene glycol and water solution utilized in the hot water system.

#### **2.06 COILS**

- A. Chilled water coils shall be as specified in Section 23 05 05 and as listed on the Mechanical Equipment Schedule.

#### **2.07 EXPANSION TANK**

- A. Expansion tank shall be of the pressurized diaphragm type as specified in Section 23 0505 and listed on the Mechanical Equipment Schedule on the Drawings. The expansion tank diaphragm material shall be compatible with the propylene glycol solution utilized in the glycol chilled water system.

#### **2.08 WATER CHILLERS**

- A. Contractor shall provide the complete installation of the water chillers as specified on the Equipment Schedule on the drawings. The Contractor shall furnish the services of a qualified factory-trained representative to supervise the chiller unit start-up including the following:
  - 1. Testing units for leaks under pressure.
  - 2. Evacuation and dehydration of units using vacuum pump furnished by the manufacturer.
  - 3. Charging units with refrigerant.
  - 4. Starting units.
  - 5. Instructing Owner's operating personnel on unit operation and maintenance requirements and procedures.
  - 6. The start-up and instructions shall be provided for a minimum of two (2) days. In addition, a full one (1) year service warranty, including all parts, labor, refrigerant, and oil, shall be provided by the Contractor.
- B. The water chiller manufacturer shall have an approved factory authorized service agency.

- C. The Contractor shall furnish and install an automatic chiller control system as specified in the equipment schedule on the drawings and in Section 23 09 00 for fully automatic operation of the water chiller system. Electrical power, control and interlock wiring shall be provided as specified in Section 23 05 00, 23 05 49 and Division 26, Electrical.

## **2.09 PRESSURE RELIEF DEVICES**

- A. Refrigerant pressure relief devices and fusible plugs shall be installed with piping to a safe location in accordance with ANSI/ASHRAE Standard 15. Discharge shall be to atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit from any building. Discharge line sizing shall conform to ANSI/ASHRAE Standard 15.
- B. Each discharge pipe shall be equipped with a drip leg capable of holding 1 gallon of liquid. The drip leg shall include a manual drain valve.

## **2.10 PROPYLENE GLYCOL MAKE-UP UNIT**

- A. Propylene glycol make-up unit shall be as specified on the Mechanical Equipment Schedule.

## **2.11 WATER TREATMENT**

- A. Water treatment system, including shot type feeders shall be furnished by the Contractor.
- B. Tanks shall be connected to the supply and return mains by means of 3/4" pipe with valves in each connection and with a 3/8" test cock on the supply connection. Tanks shall be wall or floor mounted on steel support adjacent to system pumps. The Contractor shall provide complete installation of water treatment equipment as shown on the drawings and as required by the Owner's designated Water Treatment Agency.
- C. Chemicals as required for the system startup, operational testing shall be provided by the Owner's designated Water Treatment Agency in sufficient quantities to maintain the level of chemical concentration recommended by the Water Treatment Agency and shall be included in the contract price. The exact type of chemical treatment compounds shall be determined by the Water Treatment Agency and approved by the Owner's Representative.
- D. After system acceptance by the Owner, the continuing water treatment will be the Owner's responsibility.
- E. The Owner's designated Water Treatment Agency is: Nalco, Contact Scott at (719) 659-8988.

## **2.12 FLOW MEASURING STATIONS**

- A. Furnish and install where shown on the drawings and as specified in Section 23 0505, water flow measuring stations and automatic flow control valves.

## **2.13 PROPYLENE GLYCOL**

- A. The Contractor shall provide propylene glycol required to charge the hot water circuit to a 30% by volume mixture of propylene glycol and water. Propylene glycol shall be Dowtherm SR-1 Dowtherm 4000, or equivalent, formulated of 95.4 percent propylene glycol with all required industrial corrosion inhibitors, and with an operating temperature range of -60°F to 250°F. Provide an inactive aqueous solution that has a freeze-point approximately -20°F. Contractor shall thoroughly clean and flush piping system prior to charging with propylene glycol solution in accordance with manufacturer's recommendations. The Contractor shall fill and vent all circuits.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Piping installation shall conform to the requirements of Section 23 05 00, Common Work Requirements for HVAC, and Section 23 05 04, Pipe and Pipe Fittings. Installation of specialties shall conform to the requirements of Section 23 05 05, Piping Specialties.

### **3.02 PROPYLENE GLYCOL CHILLED WATER SYSTEM**

- A. Furnish and install all propylene glycol required for the chilled water systems to the concentrations specified herein and on the equipment schedule on the drawings. Furnish propylene glycol make-up unit with all controls and accessories necessary for a completely operational system. Contractor shall test and provide the specified concentration of propylene glycol. Contractor shall furnish a full year supply of propylene glycol and check that the system is operating properly at the desired concentration for a period of one year after start-up. Piping products, fittings, valves, specialties and other accessories exposed to propylene glycol systems shall not contain aluminum or zinc products. Pump packing, seals, and gaskets shall be suitable for use with a minimum 30% concentration of propylene glycol in the system.

### **3.03 CLEANING AND FLUSHING PIPING SYSTEMS**

- A. New chilled water piping systems installed under this Contract shall be chemically cleaned of oils, greases, dirt and mill scale. The new piping system shall be inspected by the Owner's approved Water Treatment Agency to determine the appropriate cleanout procedures and recommended cleaning chemical materials.
- B. Cleaning shall be performed in strict accordance with the chemical treatment agency and manufacturer's recommendations, and shall generally consist of the following:
  - 1. Fill, flush, and drain piping systems with water to remove loose dirt and debris from the system.
  - 2. Refill piping system with cleaning compounds, diluted to recommended concentrations and circulate for required time period.
  - 3. Drain and flush system.
  - 4. Neutralize using caustic and soda ash as required when cleaning with acid compounds.
  - 5. Drain and inspect system and repeat cleaning if necessary.
- C. In conjunction with piping system cleaning, clean and inspect all strainers and suction diffusers. Remove, bypass, or otherwise protect as necessary all piping system components which may be damaged due to chemical cleaning, including filters, instrumentation gauges, flow meters, etc.
- D. After completion of chemical cleaning and flushing, the piping system shall be immediately refilled and maintained with treated water. Under no circumstances shall cleaned piping be allowed to sit empty or filled with untreated water.

### **3.04 TESTS**

- A. All piping shall be proven tight at a hydrostatic pressure of 150% of the system design operating pressure, but not less than 125 PSI. The system shall show no loss in pressure or indication of leakage at any joint or connection for a period of one hour.

## **END OF SECTION**

## **SECTION 23 30 00**

### **AIR TEMPERING SYSTEM AND EQUIPMENT**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS**

- A. Provide all products, labor and services necessary to construct and demonstrate proper functionality of the HVAC and exhaust systems indicated on the drawings and specified herein.
- B. Conform with applicable provisions of the General Conditions, the Supplemental General Conditions and General Requirements.
- C. See Sections 23 05 00, 23 05 48, 23 05 49, 23 05 93, 23 07 00, and 23 09 00 for additional requirements.
- D. Comply with the Equipment General Requirements in Spec Section 23 05 00.

##### **1.02 SCOPE**

- A. Install control dampers supplied under Section 23 09 00. Adjust dampers for smooth operation.

##### **1.03 SUBMITTALS**

- A. Submit the following for review and approval:
  - 1. All equipment shown on the equipment schedule and elsewhere on the drawings. Submit evidence or certification that equipment complies with ASHRAE Std. 90.1.
  - 2. Ductwork construction standards, sheet metal, plenums, ductwork accessories, etc.
  - 3. Flues and vents: Materials of construction and accessories. For vents with horizontal offsets or expansion joints, submit layout for review.
  - 4. Dampers for fire and smoke control: For each type of damper proposed, submit manufacturer's literature demonstrating compliance with all aspects of the specifications and drawings. Submit manufacturer's installation instructions.
  - 5. Air Filters and Filter Gauges
  - 6. Grilles, Registers & Diffusers: Configuration, materials of construction, finish, mounting details, and performance data including throw, static-pressure drop, and noise ratings. Submit for type only, but supplier shall check and verify that the indicated diffuser type and sizing are appropriate for each area. Advise of any concerns in any areas.
  - 7. Terminal Units:
    - a. Submit the following for each type of unit: Unit construction, materials, and wiring diagrams.
    - b. Submit the following for each size unit: Dimensional data, recommended flow ranges, and performance data (pressure drop and sound data) at maximum flow.
    - c. Submit a schedule showing the following for each terminal unit indicated on the drawings: Tag number, max & min CFM, size, pressure drop, and heating system performance.

8. Layouts of systems covered by this section of the specifications. Layouts shall be at a scale appropriate for the areas shown. Include large scale sections as appropriate.

#### **1.04 QUALITY ASSURANCE**

- A. Comply with the following codes & standards:
  1. IMC 2015
  2. SMACNA HVAC Duct Construction Standards – Metal and Flexible, including Addendums – Latest Edition
  3. SMACNA Round Industrial Duct Construction Standards – 1999
  4. SMACNA Rectangular Industrial Duct Construction Standards – 2004
  5. NFPA-90A-2002 - Standard for the Installation of Air-Conditioning and Ventilating Systems
- B. Component Characteristics
  1. All components within ducts and plenums shall be non-combustible or shall have a flame spread less than 25 and smoke developed less than 50 when tested as a composite product per NFPA 255, ASTM E84, or UL 723, except where specifically permitted by the IMC and noted in the drawings or specs.

#### **1.05 SOUND LEVELS**

- A. Sound levels attributable to mechanical equipment are designed to result in sound levels of NC 40 for offices, conference rooms, and NC 35 for classrooms, etc., measured within the rooms. Mechanical equipment that has been substituted for the specified equipment shall perform within the specified equipment sound limitations, or will be replaced or adjusted as required. Sound levels attributable to duct vibration that result in noticeable noise or vibration to duct hangers, lighting fixtures, ceiling tees or diffusers shall be re-supported or adjusted until the disturbing noise is brought within acceptable limits.

#### **1.06 DIMENSIONS**

- A. Compare all drawings and verify all dimensions both on the drawings and in the field before laying-out, cutting, and fabricating the work.
- B. Refer to Section 23 05 00, Common Work Requirements for HVAC, for coordination drawing requirements.

### **PART 2 PRODUCTS**

#### **2.01 DUCTWORK AND PLENUMS**

- A. Materials: Construct all ducts, casings, plenums etc. from galvanized steel sheets except as indicated. Sheets shall be free of blisters, slivers, pits, and imperfectly galvanized spots. Reinforcing angles and bars, and duct support materials shall be same material as ductwork if exposed to the air stream, or galvanized steel if not exposed to the air stream.
  1. Galvanized Steel: Per ASTM A653/A653-03 Standard Specification for Steel Sheet, Zinc-Coat (Galvanized) or Zinc-Iron Alloy-Coat (Galvanized) by the Hot Dip Process, with minimum 1.25oz/sf zinc.
  2. Aluminum: Alloy 3003-H14
  3. Stainless Steel: 340SS, provide No. 2B finish in exposed areas



4. Fiberglass Ductwork (Ductboard): Use only where specifically noted. Minimum 1-inch thick, 3 lb. density rigid fiberglass ductboard with glass fiber reinforced vapor barrier, UL Class 1, labeled on each board per IMC.
  - a. Properties:
    - 1) Thermal conductivity for 1-inch thickness shall not exceed 0.22 Btuh/SF-F at 75 deg F
    - 2) Noise reduction coefficient of 0.80 on Mounting No. 6.
  - b. Tape: 3-inch "Hardcast" mineral impregnated woven fiber tape with an actuator/adhesive applied in accordance with the manufacturer's directions, or thermlok heat sensitive tapes. Pressure sensitive tapes will not be accepted.
  - c. Owens-Corning Fiberglass, Johns Manville, Certain-Teed or equivalent. Flexural rigidity (E.I.) average shall not be less than 475.
5. Polyvinyl Coated Galvanized Steel: Minimum 4 mil polyvinyl coating. Foremost Manufacturing Company, Southfield, Michigan. Model PCD 4 by 1 for exterior coating only, or Model PCD 4 by 4 for both interior and exterior coating.
- B. Flexible Ducts: Factory fabricated, listed as a Class 1 Air Duct per UL 181 with aluminum foil interior liner, corrosion resistant helix mechanically locked to fabric to ensure dimensional stability, helix separated from air stream, R-5 fiberglass insulation, and metalized outer vapor barrier. Ducts shall be rated at 10-inch positive pressure, 5-inch negative pressure, 0.1 perm per ASTM E96, and -20 to +250°F. Flexmaster Type 3M, Thermaflex M-KC, OAE.
- C. Ductwork Accessories
  1. Sealers: Water based, for use on galvanized steel and with the other materials specified herein, suitable for use at -20 to +200°F and duct pressures to 10 inches wg, dry to the touch within 12 hours, sufficiently flexible to pass a 0.25-inch mandrel test, listed per UL-181A & 181B, and suitable for storage and application at 40–110°F. Approved Manufacturers: Carlisle Coatings & Waterproofing "Hardcast," Foster, RCD, AM Conservation Group, OAE.
  2. Tapes: 4" woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal. Water, mold, and mildew resistant for indoor and outdoor service. Sealant shall be modified styrene acrylic.

## **2.02 SHEET METAL ACCESSORIES**

- A. Dampers: Factory fabricated, suitable for use with air at -20 to +240°F, galvanized steel housing and blades except as noted, rated for indicated pressures in either direction and performance rated per AMCA-500.
  1. Shafts: Square or hexagonal steel, 3/8-inch or 1/2-inch, continuous through damper, mechanically fastened to damper blade, and extending through frame as required for actuator or standoff bracket and locking quadrant as required by table below.
  2. Bearings: Provide for each side of each shaft, molded synthetic or stainless steel sleeve type.
  3. Multi-blade dampers: Except as indicated, provide parallel-blade for 2-position applications and opposed blade for modulating applications. Provide jackshafts as required to drive large dampers.

4. Air pressure drop shall not exceed:
  - a. Dampers rated at 1500 FPM: \_\_\_ in wg at 1500 FPM
  - b. Dampers rated at 4000 FPM: \_\_\_ in. wg at 4000 FPM
5. The dampers described in this section are assigned Type Numbers D1 through D23. The following table summarizes key characteristics of each type of damper. Drawings and Part 3 – Execution, indicate which type of damper to use in each application.

Type	Shape	Blade	Max Size (inches)	Multiple Sections	Rated Velocity (FPM)	Rated Shutoff Press. (in. wg)	Seals	Leakage (CFM/SF @ 1 in. DP)	Notes	Ruskin Model
D1	Rect	Flat	36 x 12	No	1500	2.5	No	--	1	MD15
D1	Rect	3V	48 x 48	No	1500	2.5	No	--	1	MD15
D2	Rect	Flat	36 x 12	No	1500	2	No	--	1	MD25
D3	Rect	3V	48 x 48	Yes	1500	2	No	80	1	MD35
D4	Rect	3V	48 x 72	Yes	1500	2.5	No	40		CD35
D5	Rect	3V	48 x 72	Yes	1500	2.5	Yes	4		CD36
D6	Rect	Airfoil	60 x 72	Yes	4000	6	Yes	2	2	CD50
D7	Rect	Airfoil	60 x 72	Yes	4000	6	Yes	2		CD60
D20	Round	Flat	20	No	1500	2	No	40	1	MDSR25
D21	Round	Double	40	No	4000	10	Yes	4		CDR25
D22	Round	Double	24	No	4000	6	Yes	6		CDSR25
D23	Oval	Double	72 x 24	No	4000	10	Yes	4		CDO25

Note 1: Provide locking hand quadrant and 2-inch standoff bracket

Note 2: Aluminum Construction

- B. Flexible Connectors: Except as noted flexible connectors shall be heavy fiberglass cloth; coated to be air tight, water tight, fire retardant; suitable for temperatures of -20 to +200° F; rated for 10 in. wg positive or negative; with tensile strength minimum 450 lb/inch in the warp and 340 lb/inch in the filling. Provide flexible connectors in 3-3-3 configuration, with 3-inch galvanized steel strip along each edge and 3-inches of flexible fabric in the center.
  1. Standard Applications: Flame spread 20, smoke developed 40, Ventfabrics Ventglas OAE
  2. Applications Exposed to Sun and Weather: Double coated with du Pont Hyphalon, Ventfabrics Ventlon OAE.
  3. Applications from 200 – 500° F: Tensile Strength 285 lb/inch in the wrap and 185 lb/inch in the filling. Ventfabrics Ventsil OAE
  4. Corrosive Applications: Teflon coated, Ventfabrics Ventel OAE.
- C. Duct and Plenum Access Doors: Galvanized steel, gasketed. Size as required to properly inspect and service components located within the ductwork. Ruskin, Acudoor, Ductmate, OAE.
  1. Rectangular ducts up to 2-inch positive or negative SP: Minimum 22 gauge frame and door thru 12-inch size, 20 gauge door for larger sizes, double gasketed (between door and frame, and between frame and duct) with cam locks, either hinged or removable. Ruskin ADH22, ADC22, ADHW22, or ADCW22, Ventfabrics, OAE

2. Round or Rectangular Ducts to 12-inch Positive Pressure: Removable oval sandwich style with gasketed inner door, insulated outer door, and large hand knobs. Ruskin ADR and ADF.
  3. Ducts to 12-inch Negative Pressure: Ruskin ADHP-3.
  4. Plenum Access Doors: Factory fabricated frame and door rated to 4-inch positive or 8-inch negative pressure. Provide mill finish and neoprene seals to limit leakage to less than 0.1 CFM/inch perimeter with door closed. Doors shall open against air pressure.
    - a. Frame: Extruded aluminum with 1.5-inch flange and mitered corners
    - b. Door: Extruded aluminum mitered frame, double wall 24-gauge galvanized steel panel with minimum R-5 insulation isolated from the air stream, full-length piano hinge and two heavy-duty latches similar to Ventlok 310.
    - c. Approved Manufacturers: Ruskin GPAD or approved equal.
- D. Turning Vanes:
1. Single wall: Per SMACNA HVAC Duct Construction Standards Figure 2-3 & 2-4.
  2. Double wall: Airfoil shape with smoothly rounded entry nose and extended trailing edge, minimum 2" x 3" vane cross section, hot dipped galvanized steel, 26-gauge vanes, 24-gauge runner, each vane double pinned to each runner, field adjustable to required elbow aspect ratio. Performance shall not exceed the following for a 24 x 24 elbow at 2000 FPM average: Air pressure drop 0.105 in. wg; sound generated 54 dB re 10<sup>-12</sup> watts. Aero/Dyne Co. Model HEP, Airsan, Elgen, or equivalent.
- E. Roof Curbs and Equipment Support Rails: Factory fabricated, minimum 12-inch high, galvanized steel, configured to account for roof pitch where pitch exceeds 1/4-inch/ft or where required by manufacturer of supported equipment. Coordinate with roofer and provide cant and step if needed to match roof construction.
1. Roof Curbs: 1.5-inch fiberglass insulation with nominal 2" x 2" wood nailer. Provide damper tray where a damper is indicated. Thycurb TC, Greenheck, OAE.
  2. Equipment Support Rails: Nominal 2" x 4" wood nailer. Thycurb TEMS, Greenheck OAE
- F. Louvers: 4-inch extruded 6063-T5 aluminum alloy frame and blades with flange, mill finish, and 1/2-inch galvanized steel bird screen.
1. Structural: Designed and furnished to carry wind load of not less than 20 psf. Intermediate mullions and supports if provided as part of louver, shall not be visible from the exterior.
  2. Air Pressure Drop: Less than 0.20 in wg at 1000 FPM over free area (8.58 square feet), intake or exhaust per AMCA 500 based on 48 x 48 test sample.
  3. Moisture Penetration: Less than 0.01 oz/sf over 15 minute test per AMCA-500 at 873 FPM intake over free area based on 48 x 48 test sample.
  4. Ruskin ELF375DX OAE.
- G. Acoustic Louvers
1. Ruskin ACL 1245, 12 inches deep, with 45 degree blade angle, 22 percent free area (48" x 48" typical unit with .15 inch w.g. maximum pressure drop, at 4277 cfm

air flow). Frame and blade material shall be galvanized steel. Free field noise reduction shall be:

Band Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Reduction (db)	14	13	15	20	23	22	20	20

- 2. Provide bird-screen, steel channel frame, Ruskatherm blanket insulation, and perforated steel interior surface that covers insulation.
- H. Thermometers: As specified in Section 23 0505.
- I. Barometric Pressure Balance Dampers: Air Balance, Inc. units with adjustable counter weight, aluminum air foil design blades, nylon bearings. Match frame assembly to wall or duct.

**2.03 FLUES AND VENTS FOR FUEL-FIRED EQUIPMENT**

- A. General: Factory-built metallic vent system, UL Listed components. Each component shall bear indication of its UL listing.
  - 1. Heat Resistant Paint: Glidden, Metallite OAE.
  - 2. Approved Vent Manufacturers: Metal Fab, Metalbestos, Schebler, Ampco, OAE.
- B. Type IV Vent: For use with Category II or Category IV appliances (natural gas or propane-fired, positive or negative pressure, condensing, not exceeding 550° F exhaust temperature). Listed per UL-1738, double wall with 1-inch clearance and spacers to maintain alignment.
  - 1. Inner Pipe: AL2904C superferritic SS manufactured by Allegheny Ludlum, with welded seams, connected with V-bands, and sealed with high temperature silicone sealant. Rated at 6 inches water. Thickness: 0.015-inch through 12-inch size; 0.024-inch for 14-inch and larger sizes.
  - 2. Outer Pipe: Seal with V-band of same material as outer pipe. Provide silicone sealant for portions exposed outdoors. Thickness: 0.018-inch through 12-inch size; 0.024-inch for 14-inch and larger sizes.
  - 3. Options and Accessories:
    - a. Outer Wall: Aluminized steel.
  - 4. Metal Fab Type CG

**2.04 DAMPERS FOR FIRE AND SMOKE CONTROL**

- A. General: Factory assembled and UL listed as an assembly, suitable for horizontal or vertical air flow and for ducted or un-ducted applications. Fire dampers (FDs) shall be listed per UL 555, smoke dampers (SMDs) shall be listed per UL 555S, and fire/smoke dampers (FSDs) shall be listed per UL 555 and UL 555S. Units shall be galvanized steel except as noted. Approved manufacturers: Greenheck, Ruskin, Potorff, or approved equal.
- B. Combination Fire/Smoke Dampers: Factory assembled complete with damper, actuator, thermal link, and all specified accessories, all mounted on a sleeve.
  - 1. Construction: Round blades, rectangular parallel blades and rectangular opposed blades are acceptable, except dampers shall be rectangular opposed blade type when installed in any of the following conditions: within 10 diameters of a fan or supply register, within 3 diameters of an elbow. Internal frames in rectangular FSDs shall be low profile type for ducts 17"H and less.

2. All components factory installed and wired, including actuator, thermal link, position switches, temperature over-ride (if specified), test switch (if specified), etc. Mount all such components on outside of FSD sleeve to the side of duct (not top or bottom) except where indicated or approved. FSDs must be suitable for rotating the unit 180-degrees so these components can be on either side of the duct.
3. Air pressure drops shall be certified per AMCA 500D. Pressure loss coefficient  $C_o$  shall not exceed the following when tested per AMCA Figure 5.3:

<u>Size (in)</u>	<u>3-V Blade</u>	<u>Airfoil Blade</u>	<u>Round</u>
12 x 12	2.41	2.01	NA
24 x 24	0.65	0.60	NA
36 x 36	0.44	0.27	NA
12 x 48	0.76	0.91	NA
12 Round	NA	NA	0.33
24 Round	NA	NA	0.23

4. Listed for installation within wall, floor or ceiling assemblies as indicated on drawings.
  - a. Ratings, except as noted: 1.5-hr Fire Rated, Leakage Class 1, 350°F, 4-inch Static Pressure, Dynamic.
    - 1) Up to 1600 FPM: Greenheck FSD-211 (3-V blade type), OFSD-211, or FSDR-511 (round).
    - 2) Up to 3000 FPM: Greenheck FSD-311 or 311V (airfoil blade) or OFSD-311.
  - b. 3-Hr Rated Walls: Greenheck FSD-231.
  - c. Stainless Steel: Greenheck SSFSD-211 or SSFSDR-511 (round).
5. Actuators: Electric 2-position, 115/1/60 (provide factory wired transformer if required), normally closed, spring return, NEMA-1 except as noted. Actuator shall fully re-open damper when power is restored after any power interruption.
6. Accessories
  - a. Transitions: Provide round-to-rectangular, oval-to-rectangular, or rectangular-to-rectangular transitions as appropriate for the application.
  - b. Thermal Link: Provide re-settable bi-metallic thermal link to initiate closure when the air temperature within the duct rises to 165° F. Where indicated provide thermal links for operation at 212° F, 250° F, or 350° F. Thermal link shall be easily resettable from outside the duct.
  - c. Position Switches: Provide dry contacts for remote monitoring of damper open and closed positions.
  - d. Retaining plates and angles: Provide as required. Galvanized steel specifically designed for the particular FSD and included as part of the UL Listed assembly.
  - e. Installation decals: Provide installation decals on the sleeve which give the installer clear installation instructions.

- f. Temperature Override Control: Provide controls so that the thermal link can be over-ridden and the FSD opened for smoke control, even if the air temperature exceeds the setting of the thermal link, provided the temperature does not exceed 350° F.
- C. Smoke dampers: Similar to fire/smoke dampers noted above, except as follows:
- 1. Smoke dampers shall comply with UL 555S, but need not comply with UL 555.
  - 2. Smoke dampers need not have a fire rating.
  - 3. The thermal link and temperature override are not applicable.
  - 4. Suitable for installation within a wall, floor or ceiling assemblies as indicated.
    - a. Ratings, except as noted: Leakage Class 1, 350° F, 4-inch Static Pressure, Dynamic.
      - 1) Up to 1600 FPM: Greenheck SMD-201 (3-V blade type) or SMDR-501 (round).
      - 2) Up to 3000 FPM: Greenheck SMD-301, 301V (airfoil blade) or SMDR-401.
    - b. 6-inch pressure rated: Similar to Greenheck SMD-401
    - c. Stainless Steel: SSSMD-201 & SSSMDR-501 (round).
- D. Fire Dampers: Dynamic rated, suitable for closing against 8-inch differential pressure. Curtain type with sleeve and 165°F replaceable fusible link, resettable. Provide round-to-rectangular, oval-to-rectangular, or rectangular-to-rectangular transitions as appropriate.
- 1. 1.5-hr rated: Greenheck DFD-155
  - 2. 3-hr Rated: Greenheck DFD-355.
  - 3. Provide 212° F fusible links for high temperature applications.
- E. Ceiling Radiation Dampers: UL Classified for use with fire rated floor/ceiling assemblies, with 165°F fusible link replaceable through the damper assembly, 1.5-hr rated except as noted. Greenheck CRD-1, CRD-2 (round), CRD-60, or CRD-60X. Provide 212° F fusible link and 3-hr rated dampers where indicated.

## **2.05 FILTERS AND FILTER GAUGES**

- A. Rated per ASHRAE Std. 52.1; Class 1 or 2 per UL Std. 900; glass fiber media; suitable for operation from -20° F to +170° F; corrosion resistant; suitable for installation with pleats either horizontal or vertical, and for air flow horizontal, vertical upflow, or vertical downflow; suitable for face velocity up to 625 FPM. Unless specified elsewhere, pre-filters shall be MERV-7, and final filters (where specified) shall be MERV-14. AAF, Camfil Farr, or approved equal.

		MERV RATING						
		7	11	14	11	14	11	14
Description								High Capacity
Configuration		2-inch or 4-inch	12-inch Cartridge		6-inch Cartridge		12-inch Cartridge	
Initial Resistance	in. wg.	0.26	0.25	0.58	0.39	0.58	0.29	0.49
Rated Velocity	FPM	500	500	500	500	500	500	500
Max Velocity	FPM	625	625	625	625	625	750	750
Recommended Final Resistance	in. wg.	0.7	1.5	1.5	1.5	1.5	1.5	1.5
Gross Media per 24 x 24 Filter	SF	14 Pleats per foot	62	62	105	125	175	175
Housing		Cardboard	Polystyrene or Aluminized Steel	Polystyrene or Aluminized Steel	Polystyrene or Aluminized Steel			
Frame		Channel	Gasketed		Gasketed		Gasketed	
AAF Model		Perfect Pleat	VariCel RF		VariCel M-Pak		VariCel V	
Camfil Farr Model		3030	RigaFlow					

- B. Filter Gauges: Provide a filter gauge for each bank of filters. Gauges shall be magnehelic type with static pressure tips and inter-connecting piping. Ranges shall be 0-1 inch w.g. for all filters except bag filters which shall have a range of 0-2 inches w.g.

## 2.06 TERMINAL UNITS

- A. General: Factory packaged unit with casing, air valve, air flow sensor. If the following sections are specified or required, provide them as part of the factory package: heating section, fan, and sound attenuator. Terminal units (TUs) shall be suitable for variable volume operation over the scheduled air flow ranges. Air flow and sound performance shall be rated per ARI 880. All materials in the air stream shall comply with the requirements of UL-181 and NFPA-90A.

### 1. Unit Construction:

- a. Casing: Minimum 22-gauge galvanized steel with round inlet collar, rectangular outlet collar, 3/4-inch acoustic lining with cut edges coated with sealant.
- b. Air Valve: Heavy gauge metal damper, shaft to extend through casing, self-lubricating bearing, with leakage not to exceed 2% of rated air flow when closed with 3-inch inlet pressure.
- c. Air Flow Sensor: Cross configuration located at inlet of assembly, accurate to within 5% with 90° elbow directly at inlet connection. Provide

- d. Sound Attenuator: Galvanized steel with acoustic lining. Provide aluminum liner if specified for casing.
- e. Heating Section:
  - 1) HW Coils: Copper tubes, aluminum fins, galvanized steel casing, sweat connections, ARI rated, minimum 300 psi rated. Size heating coils for the capacities indicated on the equipment schedule. Provide single row coils wherever they can do the specified heating duty. Provide 2-row coils where indicated and where required for the indicated heating capacity. Do not exceed 0.5-inch static pressure drop for the entire unit (terminal unit, heating coil and sound attenuator). Where necessary to limit pressure drop, either over-size unit or provide a separate, larger (lower pressure drop) heating coil to be installed in the discharge ductwork.
  - 2) Electric Heaters: Factory installed and wired with all necessary safety controls, UL listed as an assembly, with galvanized steel enclosure, 80/20 nickel chrome heater elements, electronic modulating control with 4-20 mA input signal from DDC system, air flow switch, access door with door interlock disconnect switch, automatic reset primary thermal cutout switch, manual reset secondary thermal cutout, 24-V control transformer, NEMA-1 enclosure for all electrical components with hinged access door with wiring diagram. Controller shall be solid state type to minimize electrical interference and for silent operation.
- 2. Sound Data: The equipment schedules show maximum allowable NC levels based on unit sound power measured per ARI-885, and sound attenuation per ARI-885 Appendix E with a Type 2 ceiling. Do not exceed the scheduled sound levels.
- 3. Controls: Controls will be supplied by the controls contractor for installation by terminal unit (TU) supplier. Coordinate with controls contractor who will ship controls to TU manufacturer. TU manufacturer shall install controls onto terminal units.
- 4. Approved Manufacturers: Price, Anemostat, Titus, Krueger, or approved equal.
- B. VAV Reheat: Single duct type with reheat as indicated, Price SDV.

## **2.07 GRILLES, REGISTERS AND DIFFUSERS**

- A. General: Performance rated per ASHRAE Std 70, *Method of Testing for Rating the Performance of Air Outlets and Inlets*, steel with baked white enamel finish except as noted, for installation on a fixed surface or a lay-in T-bar ceiling as indicated on architectural drawings, rigidly constructed, vibration free, with inlet collar of sufficient length to connect inlet ductwork, sized as shown on drawings. Where frames are provided for installation in fixed surfaces, frames shall be approximately 1-1/8" wide. Sound performance rated per ADC and based on room absorption of 10dBre10<sup>-12</sup> Watts and one diffuser.
  - 1. Approved Manufacturers: Price, Krueger, Titus, Anemostat, OAE
- B. Types as follows. See also the Grille and Diffuser Schedule on drawings.
  - 1. Square Ceiling Diffusers: Louvered type, 4-way pattern, 1-piece smooth aerodynamic surfaces with no corner joints, three louvers for 12-inch sizes, four louvers for 24-inch sizes, removable louver assembly, round neck, to provide



stable, horizontal air flow without dumping down to 75 FPM inlet velocity for ceiling applications, and down to 20% of maximum air flow for non-ceiling applications. Price SCD.

2. Round Ceiling Diffusers: Louvered type, 360-degree distribution, four separate 1-piece smooth aerodynamic louvers, adjustable air flow pattern (horizontal vs. vertical), round neck. Price RCD.
3. Ceiling Return, Exhaust and Transfer Grilles: 1/2" x 1/2" x 1/2" egg crate type, steel frame for surface mounting or T-bar ceiling per application, aluminum grid. Price Series 80.
4. Ceiling Rectangular Directional Diffusers: Louvered type, directional pattern as indicated on drawings, with removable louver assembly. Price SMD.
5. Sidewall Supply Registers: Double deflection with ganged horizontal front bars, individually adjustable vertical rear bars, 3/4" bar spacing and surface mounting frame. Price 520.
6. Sidewall Return, Exhaust and Transfer Grilles: Fixed horizontal bars on 3/4" centers set at 30-45 degrees, surface mounting frame. Price 530.
7. Ceiling or Sidewall Linear Supply Diffusers: Extruded aluminum with baked white enamel finish, frame suitable for lay-in or surface mounting as per the architectural drawings, all aluminum construction, flat black interior surfaces, air flow deflection vanes to provide each slot with individually and fully adjustable 180° air pattern from horizontal to vertical or in between, self-aligning devices to ensure proper alignment where multiple sections are required, and corner pieces as necessary for a continuous appearance. Provide galvanized steel side inlet plenum matched to diffuser, with plenum extension if necessary to match adjacent construction. Performance data is based on 3/4-inch slots unless otherwise indicated. See plans for required air flow, diffuser length, and number of slots. Price SDS with SDA or SDB plenum, Krueger 1910, or equivalent.
8. Ceiling or Sidewall Linear Return Registers: As specified for sidewall linear supply diffuser except without air flow deflection vanes. Price SDS.
9. Stainless Steel Sidewall Return/Exhaust Registers: Fixed horizontal blades at 1/2" spacing and 45° deflection, flange for surface mounting, and SS 90° quick-release fasteners to mount grille to frame. Provide mill finish for blades and No. 4 finish for flanges. Price Model 735H.
10. Stainless Steel Slot Diffuser: Consist of a 0.037", 304 stainless steel plenum with continuous welded joints and chamfered corners to facilitate cleaning. The diffuser face shall be stainless steel construction with slots and fixed pattern deflectors. Plenums shall have stainless steel inlet collars complete with removable dampers from plenum face. The removable dampers shall be opposed blade type, constructed of stainless steel. Damper shall be adjusted without removing face of diffuser. The diffuser face shall be attached by stainless steel 90° quick-release fasteners and safety cable to open easily. The diffuser face, mounting frame, face and interior surface of plenum shall have a #4 finish. Krueger Model HORDSS or equivalent.
11. Laminar Flow Diffuser: Extruded aluminum construction and plated steel to inhibit corrosion. The perforated face plate, damper deflector, interior baffles and diffuser back pan plenum assembly shall be of 0.040 aluminum. The perforated face plate shall open easily with 90° quick-release fasteners and safety cable for easy cleaning and damper adjustment. B11 Sterile White-Thermal Setting finish. Krueger Model LFD or equivalent.

## 2.08 FANS

### A. General

#### 1. Construction

- a. Factory fabricated fan, motor, drive and accessories, UL listed, with air flow rated per AMCA 211 and sound rated per AMCA standards.
- b. Fan wheel: Statically & dynamically balanced, with shaft sized so first critical speed is minimum 25% above maximum operating speed.
- c. Motor and Drive: Premium efficiency ODP motor per Spec Section 23 0500, direct drive or belt driven as indicated in schedule on drawings, bearings with 100,000 hr L-10 life.
  - 1) Variable Speed Applications: Provide Class F insulation.
- d. Belt Drives: Adjustable pitch sheave up to 5 Hp, fixed pitch above this Hp, cast and machined pulleys with all components sized for 150% of motor Hp.
- e. Dampers:
- f. Accessories:
  - 1) Roof Curb: Minimum 12-inch galvanized steel, fiberglass insulated, with wood nailer, damper tray and flange. Provide cant and step if needed for proper seal with roof.

#### 2. See Section 23 05 48 for Vibration Isolation requirements.

### B. Centrifugal Roof Exhaust Fans

1. Leakproof construction.
2. Housing: Spun aluminum construction, reinforced wind band welded to one-piece curb cap with mounting holes on the side and integral spun venturi, spun aluminum motor compartment with readily removable cover and breather tube. All other structural components shall be galvanized steel.
3. Fan wheel: Backward inclined, centrifugal, non-overloading.
4. Motor and Drive: Motor out of the air stream, cooled with ambient air. Motor, drive and fan wheel resiliently mounted on neoprene isolators.
5. Electrical: Disconnect NEMA-1 if protected from the weather, or NEMA-3R if exposed to the weather, wired to motor, with all wiring and components per NEC and either UL Listed or UL recognized.
6. Accessories: Stamped aluminum nameplate, hinge kit to allow tilting fan up to inspect wheel, retaining chains, conduit chase and roof curb.
7. Approved Manufacturers: Greenheck Type, G, GB, CUE or CUBE as indicated. Cook, ACME, OAE.

## 2.09 COILS

- A. Galvanized steel casing, copper tubes and aluminum fins except as noted, with tubes mechanically expanded into fins, circuited to allow completely draining and venting coil, drain and vent connections, with performance rated per ARI. Do not exceed scheduled air or water pressure drops by more than 5 percent.

**PART 3 EXECUTION**

**3.01 DUCTWORK AND PLENUMS**

A. Ductwork

- 1. Construct ductwork with wall thicknesses and reinforcing per the SMACNA HVAC Duct Construction Standards, Latest Edition
- 2. Pressure Classes: Construct ductwork to the following pressure classes:

<u>Duct Element Description</u>	<u>Relative Pressure</u>	<u>Pressure Class</u>
From Outside Air Louver to Filter:	N	1"
From Air Handling Unit to Terminal Unit:	P	4"
From Single Zone AHU to Diffuser	P	2"
From Terminal Unit to Diffuser:	P	1"
From Return Grille to Fan:	N	1"
From Return Fan to Relief Louver:	P	1"
From Exhaust Register to Exhaust Fan:	N	2"

- 3. Minimum thickness for sheet metal ductwork: 26 gauge.
- 4. Sealing: Seal ductwork and plenums as follows: All transverse joint, longitudinal seams and duct wall penetrations.
  - a. Apply duct sealer to inside of seams and joints. Do not use pressure sensitive tape as the primary sealant.
- 5. Clearance to earth: Maintain minimum 4-inch separation between ductwork insulation and earth.
- 6. Openings in Ductwork: During installation protect the open ends of ducts to prevent debris and dirt from entering.
- 7. Provide turning vanes in square elbows of low velocity supply and exhaust ductwork.
- 8. Collars: Where exposed ducts pass through walls, floors, or ceilings, provide a tight-fitting, flanged sheetmetal collar around duct and tight against finished surface to cover opening and present a neat appearance. Lock collar to duct.
- 9. Cross Breaking: Cross-break low velocity rectangular sheetmetal ducts on all four sides. Cross break sheet metal between standing seams or reinforcing angles. The center of cross break shall be of the required height to assure surfaces being rigid. Do not cross-break high velocity plenum panels.
- 10. Grilles Registers and Diffusers: Install plumb, affix to general construction as appropriate, make air-tight connection to ductwork, and adjust air flow pattern to achieve appropriate velocities in the occupied zones. Request direction from Engineer if any question exists regarding proper air flow adjustment.
- 11. Duct Thermometers: Provide thermometers to indicate mixed air, outside air, and supply air of indoor air handling units over 2,500 cfm and where shown on the Drawings.
- 12. Test Holes: Provide test holes in ducts at locations where testing is required per Section 23 0593 and as requested by the T&B agent. Close test holes with rubber plugs. Reseal all insulated ductwork with the same insulation, jacket and vapor barrier material after T&B is complete.

13. Closure Systems:
  - a. Rigid Air Ducts: Comply with UL 181A – Standard for Closure Systems for Use with Rigid Air Ducts and Air Connectors.
  - b. Flexible Air Ducts: Comply with UL 181B – Standard for Closure Systems for Use with Flexible Air Ducts and Air Connectors.
14. Factory Made Air Ducts: Install in accordance with the terms of their listing and the manufacturer's recommendations.
15. Acoustic Insulation: See Section 23 0700, HVAC Insulation. Fabricate ductwork so the dimensions indicated on the drawings are the clear dimensions for air flow inside the acoustic insulation.
16. Coordination with Building Construction
  - a. General: The drawings show the general intended configuration of the ductwork. Provide additional offsets where necessary to coordinate with the building construction or with the work of other disciplines. Transition ductwork as required at no change in contract price. Where this is necessary, submit for review and maintain the indicated flow areas.
  - b. Ductwork is frequently routed through bar joists and between bar joists. Coordinate duct locations with joist submittals prior to fabrication.
17. Exterior Ductwork: Install ductwork as specified herein and insulate per Section 23 07 00. Then enclose the exposed top and sides of ductwork with 28 gauge galvanized steel or 26-gauge aluminum to protect the insulation. Repair any damage to the insulation jacket. Slope sheet metal enclosure to shed water.

B. Hangers and Supports

1. Securely support ducts per SMACNA. Provide support at each concentrated load and at each change in direction. Provide supports on each side of rectangular ducts and equipment. Where vertical ducts pass through floors or roofs, support with angles or other steel members attached to minimum two opposite sides of duct. Size supports to rigidly support the ductwork. Provide lateral support.
2. Hangers for terminal units: Minimum four 1" x 1/8" galvanized steel straps or two angle trapeze supports.
3. Horizontal Round Ducts: 30 inches and larger in diameter: Provide 2" x 2" x 1/8" black steel rolled angle ring on 6-ft centers, and support from angle.

C. Plenums

1. Single Wall Plenums: Shop fabricated minimum 16 gauge galvanized sheet steel. Horizontal and vertical panels are to be fabricated of 2' x 10' sheets. Unless otherwise dimensioned on the Drawings, access door frames are not to exceed 16-3/4 inch width. Where door width exceeds 16-3/4 inches, vertical panels shall be fabricated around 2" x 2" x 1/4" angle. If the plenum height or width exceeds 9 feet, provide a 2-1/2" x 1/8" continuous galvanized steel strip between each horizontal and vertical seam. Provide high velocity cement at each joint during panel assembly. Panels are to be bolted as shown on the details or tack welded at the Contractor's option; however, enough panels must be bolted to allow removal of equipment from the plenums. Cover interior surfaces with 2-inch thick, acoustical lining.
  - a. Plenum Access Doors: Minimum two fastening devices that can be operated on either side of the door; these devices to be readily operated

and moving parts to have bronze pins. All parts of the door shall be constructed of galvanized iron and shall be airtight. Latches: "Ventlock" No. 310 OAE.

2. Double Wall Plenums: Factory fabricated, Semco or equivalent. Submit shop drawings for review including overall configuration, construction details, access doors, erection drawings and structural calculations stamped by a registered structural engineer.
  - a. Factory fabricated, minimum 18 gauge galvanized steel outside, perforated galvanized steel inside, with 4-inch sound insulation between. Plenums downstream of final filters shall have solid inner panel.
  - b. Heat transfer coefficient shall not exceed 0.0575 BTUH/SF-F at 75 deg F mean temperature. Pressure Ratings: 12 in. wg positive and 10 in. wg negative.
  - c. Noise attenuation shall be as follows in decibels, re 10<sup>-12</sup> watts.

	OCTAVE BAND							
	1	2	3	4	5	5	7	8
Attenuation, db:	26	30	36	41	34	36	44	37
Noise Absorption Coeff:	0.22	0.39	1.20	1.36	1.03	0.84	0.74	0.68

### 3.02 DUCTWORK ACCESSORIES

- A. Dampers: Install dampers with shafts horizontal. Locate dampers so that actuators are readily accessible. Verify that dampers operate smoothly.
  1. Manual Dampers (Balancing Dampers): Damper Types D1 through D23 are all suitable for use as manual balancing dampers. Provide locking quadrants.
  2. Automatic Applications: The following damper types may be used for automatic applications: D4, D5, D6, D7, D21, D22 and D23. Provide damper actuators per Section 23 0900.
- B. Flexible Connectors: Provide flexible connectors at locations indicated on the drawings and at the inlet and outlet of each fan directly connected to duct system. Select flexible connectors appropriate for the application. Provide steel spring vibration isolators spanning across flexible connections of isolated fan housings to prevent blow-apart due to horizontal displacement of fan housings.
- C. Access Doors: Provide as required for access to all components located within ductwork. Locate to facilitate access to such components. Size as appropriate. In addition to locations specifically called out on the drawings or elsewhere in these specs, provide access doors at the following: FDs, SMDs, FSDs, instrumentation mounted within ductwork, fan bearings.
- D. Turning Vanes: Provide turning vanes in square elbows of all supply ducts. Single wall turning vanes may be used in ducts up to 1500 FPM and 24-inch vane length. Provide double wall turning vanes in ducts exceeding either of these criteria.
- E. Roof Curbs and Equipment Support Rails: Coordinate the location of roof curbs and rails with the roof structure, ductwork distribution, and other work. Install after roof deck is installed but before roof is insulated. Mount curbs and rails securely to deck per manufacturer's recommendations. Provide counterflashing as required.
- F. Louvers: Coordinate louver size and construction with structural and architectural openings to assure proper fit. Securely fasten louver to internal structural members to withstand a force of 25 lb/sf plus a safety factor of 3.0.

- G. Instrumentation: Install duct thermometers and filter gauges so they are easily readable from the operator level.

### **3.03 FLUES AND VENTS FOR FUEL-FIRED EQUIPMENT**

- A. General: Install per the drawings and these specifications, manufacturer's instructions, the terms of the vent's UL Listing, the IMC, IFGC, and NFPA-211.
  - 1. Use the same type vent for the entire system from the equipment connection to the termination outside. Provide all fittings, transitions, adapters, supports, storm collars, etc.
  - 2. Install per the venting requirements of the appliance manufacturer. Comply with clearances per UL Listing. Minimize offsets and resistance to flow. System shall develop a positive flow adequate to remove products of combustion to outside. Do not run any portion of the vent system through any supply or return air duct or plenum. Do not connect the vent from any Category I or II (non-positive pressure) appliance with any Category III or IV (positive pressure) appliance. Do not install any manually operated damper at any point in vent system.
  - 3. Properly support the system and make provisions for thermal expansion. Install so as to prevent leakage of flue gases into the building. Provide drain connections where condensate is likely to accumulate, and pipe to spill over floor drain.
  - 4. Provide ventilated thimbles where vents pass through walls, floors and roof. Paint all galvanized or aluminized steel parts exposed to the weather with one coat of corrosion and heat-resistant primer, and one coat of heat resistant paint.
  - 5. Terminate low heat appliances as indicated on the drawings, but not less than:
    - a. 3 ft above the highest point where the vent passes the roof.
    - b. 2 ft above any portion of a building within a horizontal distance of 10 ft.
    - c. 3 ft above any forced air inlet located within 10 ft.
- B. Type B: If a draft damper is supplied with the appliance for installation in the flue, install it per manufacturer's instructions. If appliance is listed for use with a draft hood but is not supplied with one, provide a properly sized barometric draft regulator immediately in the vent outlet, and install per manufacturer's recommendations. Pitch vent up minimum 1/4-inch per foot. Join sections per manufacturer's recommendations using sheet metal screws or proprietary closure system of a UL Listed venting system. Provide vent cap.
- C. Type III and IV: Install per the drawings and these specifications, per manufacturer's instructions, per the terms of the vent's UL listing, and per NFPA-211.

### **3.04 DAMPERS FOR FIRE AND SMOKE CONTROL**

- A. Select FDs, SMDs and FSDs as appropriate to the application. Dampers may be rectangular or round, and single-section or multi-section as required, but shall not be less than the duct sizes indicated on the drawings nor larger than the maximum sizes per the UL listing for a given style of damper. Provide transitions and sleeves as required.
  - 1. FSDs may be used where SMDs are indicated provided they meet the required ratings of the indicated SMDs and provided the FSDs are installed in accordance with their listing.

- B. Install dampers in accordance with their listing. Terminate acoustic lining at dampers as necessary to ensure proper damper operation. Install actuators and access doors on the side of the duct unless space conditions preclude this. Provide adequate clearance for proper operation, and minimum 36-inch clearance for servicing actuator.
  - 1. When space conditions preclude installing actuators on the side, such components may be installed on the top or bottom of the duct provided good access to these components is maintained.
  - 2. When size requires the use of multiple dampers, provide framing to ensure the dampers remain in place.
  - 3. Provide a duct access door at each FD, SMD and FSD for inspection and maintenance. Provide minimum 1/2-inch high label, "SMOKE DAMPER," "FIRE DAMPER," or "FIRE/SMOKE DAMPER."
- C. Test all SMDs and FSDs after the system is installed to ensure proper operation based on both smoke and fire signals. Advise Owner minimum 2 weeks in advance and invite him to observe these tests. Submit a written report with a table which identifies each such damper (along with plans which indicate each such damper); gives its size, type and model number; the date on which it was tested; the test results; and places for the initials of the person performing test for the contractor and the person witnessing test for owner. Should any dampers fail to operate properly, service them and demonstrate proper operation. Reset all dampers when the testing is complete.

### **3.05 FILTERS AND FILTER GAUGES**

- A. Provide one set of MERV-7 temporary filters until testing and balancing is complete. Then immediately before the system is turned over to the Owner at the completion of the project, remove these filters and provide the specified filters.

### **3.06 TERMINAL UNITS**

- A. Install terminal units so that controls and piping components are readily accessible for normal service and maintenance. Provide minimum 3 ft clear in front of control panels.

### **3.07 GRILLES REGISTERS AND DIFFUSERS**

- A. Install grilles, registers & diffusers (GRDs) square with building construction. Mount sidewall GRDs minimum, 3-inches above floor level. If GRDs have provisions to adjust the direction of air flow, submit a written recommendation regarding the best direction for air flows, obtain written approval from the Owner's Representative, and adjust GRDs accordingly.
- B. Verify frame types with architectural RCPs prior to ordering GRDs.

### **3.08 CLOSEOUT ISSUES**

- A. Leakage Testing
  - 1. Pressure test not less than 25% of the installed ductwork of each system rated at 3 in wg or more, either positive or negative pressure. Advise Owner's Representative when systems will be ready for testing. For large systems separate tests may be made on different sections. The Owner's representative will designate the sections to be tested, but not more than 24 hours in advance of test. Cap ends of ducts as required and provide equipment as required for testing.

2. Measure duct leakage per the SMACNA HVAC Duct Leakage Test manual. Leakage shall not exceed the following:

$$L_{max} = C_L P^{0.65}, \text{ where}$$

$L_{max}$  = maximum permitted leakage, cfm/100 sf of duct surface area

$C_L$  = Duct leakage class (cfm/100 sf at 1-inch wg)

= 6 for rectangular sheet metal, rectangular fiberglass, and round flexible ducts

= 3 for round and flat oval sheet metal or fiberglass ducts

P = Test pressure. Test pressure shall match system pressure class.

3. If sample is defective, the contractor shall repair or modify the defective section and re-test it to demonstrate compliance. In addition, for each section which fails its original pressure test, the Owner's Representative will designate an additional ductwork section of similar size, for the Contractor to test. This section will be in addition to 25% area originally planned to be tested. .
4. Complete all leakage testing and repairs prior to concealing ducts.
5. Submit a test report that documents the test procedure and results. Include:
  - a. Test equipment – model numbers, technical data, calibration data, etc.
  - b. Drawings showing the extent of the systems tested.
  - c. Test results.
  - d. Dates, witnesses, and signatures of witnesses.

- B. Testing and Balancing: Test and balance the complete air tempering system as specified in Section 23 0593. It is anticipated that the TAB effort will identify some system deficiencies. Work in a cooperative manner to identify the cause of these deficiencies. Where deficiencies are due to defects in installation, or workmanship, repair as required and re-test to demonstrate proper performance.

- C. Cleaning

1. All ducts, coils, housing, registers, grilles, fans, etc., shall be clean when installed and shall be kept clean until the system is completed. As the various parts of the system are installed, they shall be wiped or blown clean and openings taped dust-tight with heavy paper or cardboard until the system is completed and ready for testing. At that time all covers and protective wrappings shall be removed. Where one has been torn or previously removed, the duct, coil, register, etc., shall be carefully cleaned of any dirt or dust that has entered the opening.

## END OF SECTION



## SECTION 23 52 16

### CONDENSING BOILERS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract apply to this Section, including General and Supplementary Conditions and Division 01 Specification Sections.

##### 1.02 SUMMARY

- A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim and accessories for generating hot water.

##### 1.03 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
  - 1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler.
- B. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 50% and 5% input firing rates at incoming water temperatures ranging from 80°F to 160°F. Test protocols shall conform to AERCO's AE-1 standards.
- C. Pressure Drop Curve. Submit pressure drop curve for flows ranging from 0 GPM to 300 gpm
  - 1. If submitted material is different from that of the design basis, boiler manufacture shall incur all costs associated with reselection of necessary pumps. Possible differences include, but are not limited to, the pump type, pump pad size, electrical characteristics and piping changes.
- D. Shop Drawings: For boilers, boiler trim and accessories include:
  - 1. Plans, elevations, sections, details and attachments to other work
  - 2. Wiring Diagrams for power, signal and control wiring
- E. Source Quality Control Test Reports: Reports shall be included in submittals.
- F. Field Quality Control Test Reports: Reports shall be included in submittals.
- G. Operation and Maintenance Data: Data to be included in boiler emergency, operation and maintenance manuals.
- H. Warranty: Standard warranty specified in this Section
- I. Other Informational Submittals:
  - 1. ASME Stamp Certification and Report: Submit "H" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

##### 1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. I=B=R Performance Compliance: Condensing boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.
- C. ASME Compliance: Condensing boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".
- D. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- E. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- F. UL Compliance: Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- G. NOx Emission Standards: When installed and operated in accordance with manufacturer's instructions, condensing boilers shall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.1; and the Texas Commission on Environmental Quality (TCEQ), Title 30, Chapter 117, and Rule 117.465.

#### **1.05 COORDINATION**

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.

#### **1.06 WARRANTY**

- A. Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Fire-Tube Condensing Boilers
    - a. The pressure vessel/heat exchanger shall carry a 10-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
    - b. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years from shipment.
    - c. All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 18 months from shipment

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide AERCO International, BMK 1500 or a comparable product by one of the following OR approved equivalent:
  - 1. AERCO International
  - 2. Buderus

3. Viessmann Manufacturing Co. (US) Inc.
4. Fulton

**2.02 CONSTRUCTION**

- A. Description: Boiler shall be natural gas fired, fully condensing, fire tube design. Power burner shall have full modulation (the minimum firing rate shall not exceed 75,000 BTU/HR input. Boilers that have an input greater than 75,000 BTU/Hr at minimum fire will not be considered) and discharge into a positive pressure vent. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be factory-fabricated, factory-assembled and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion-air intake connections, water supply, return and condensate drain connections, and controls.
- B. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 5/8" OD, with no less than 0.049" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8-inch diameter.
- C. Pressure Vessel: The pressure vessel shall have a maximum water volume of 40 gallons. The boiler water pressure drop shall not exceed 3 psig at 130 gpm. The boiler water connections shall be 4-inch flanged 150-pound, ANSI rated. The pressure vessel shall be constructed of SA53 carbon steel, with a 0.25-inch thick wall and 0.50-inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.
- D. Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of a 20-to-1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall produce less than 20 ppm of NOx corrected to 3% excess oxygen. The burner shall be metal-fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable speed cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.
- E. Minimum boiler efficiencies shall be as follows at a 20 degree delta-T:

<b>EWT</b>	<b>100% Fire</b>	<b>50% Fire</b>	<b>7% Fire</b>
160 °F	87%	87%	87%
140 °F	88%	88%	88%
120 °F	89%	90%	90.5%
100 °F	93.7%	95%	95%
80 °F	96%	98%	98.6%

- F. Exhaust Manifold: The exhaust manifold shall be of corrosion resistant cast aluminum or 316 stainless steel with an 6-inch diameter flue connection. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.
- G. Blower: The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.
  - 1. Motors: Blower motors shall comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
    - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0.
- H. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and electronic flame supervision.
- I. The boiler shall be designed such that the combustion air is drawn from the inside of the boiler enclosure, decoupling it from the combustion air supply and preheating the air to increase efficiency.
- J. Enclosure: The sheet metal enclosure shall be fully removable, allowing for easy access during servicing.

### **2.03 CONTROLS**

- A. Refer to Division 23, Section "Instrumentation and Control of HVAC."
- B. The boiler control system shall be segregated into three components: "C-More" Control Panel, Power Box and Input/Output Connection Box. The entire system shall be Underwriters Laboratories recognized.
- C. The control panel shall consist of six individual circuit boards using state-of-the-art surface-mount technology in a single enclosure. These circuit boards shall include:
  - 1. A display board incorporating LED display to indicate temperature and a vacuum fluorescent display module for all message enunciation
  - 2. A CPU board housing all control functions
  - 3. An electric low-water cutoff board with test and manual reset functions
  - 4. A power supply board
  - 5. An ignition /stepper board incorporating flame safeguard control
  - 6. A connector board
  - 7. Each board shall be individually field replaceable.
- D. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.
- E. The control panel hardware shall support both RS-232 and RS-485 remote communications.
- F. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of eight separate status messages and 34 separate fault messages.
- G. The control panel shall incorporate three self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features include:
  - 1. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based

- on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.
2. Setpoint Low Limit: Allow for a selectable minimum operating temperature.
  3. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired.
- H. The boiler control system shall incorporate the following additional features for enhanced external system interface:
1. System start temperature feature
  2. Pump delay timer
  3. Auxiliary start delay timer
  4. Auxiliary temperature sensor
  5. Analog output feature to enable simple monitoring of temperature setpoint, outlet temperature or fire rate
  6. Remote interlock circuit
  7. Delayed interlock circuit
  8. Fault relay for remote fault alarm
- I. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD-1.
- J. Each boiler shall have an oxygen monitoring system that will measure the oxygen content of the exhaust gasses in real-time. Output of O2 information shall be displayed on the C-More control panel.
- K. The Boiler Manufacturer shall supply as part of the boiler package a completely integrated AERCO Control System (ACS) to control all operation and energy input of the multiple boiler heating plant. The ACS shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the Boilers via the RS-485 port. One ACS controller shall have the ability to operate up to 32 AERCO boilers.
- L. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The ACS shall control the boiler outlet header temperature within  $\pm 2^{\circ}\text{F}$ . The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The ACS controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.
- M. The ACS shall have the following anti-cycling features:
- Manual designation of lead boiler and last boiler.
  - Lead boiler rotation at user-specified time interval.
  - Delay the firing/shutting down of boilers when header temperature within a predefined deadband.

- N. When set on Internal Setpoint Mode, temperature control setpoint on the ACS shall be fully field adjustable from 50°F to 190°F in operation. When set on Indoor/Outdoor Reset Mode, the ACS will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.
- O. When set on MODBUS Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint as an external communication utilizing the MODBUS protocol is supplied via the RS-232 port. The ACS controller shall have a vacuum fluorescent display for monitoring of all sensors and interlocks. Non-volatile memory backup of all control parameters shall be internally provided as standard. The controller will automatically balance the sequence of operating time on each boiler by a first-on first-off mode and provide for setback and remote alarm contacts. Connection between central ACS system and individual boilers shall be twisted pair low voltage wiring, with the boilers 'daisy-chained' for ease of installation.

#### **2.04 ELECTRICAL POWER**

- A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.
- C. Electrical Characteristics:
  - 1. Voltage: 120V
  - 2. Phase: Single
  - 3. Frequency: 60 Hz
  - 4. Full-Load Current 18 Amps

#### **2.05 VENTING**

- A. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with operating temperatures up to 230°F, condensing flue gas service. UL-listed vents of Polypropylene and Al 29-4C stainless steel must be used with boilers.
- B. The minimum exhaust vent duct size for each boiler is eight-inch diameter.
- C. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the boiler and the outdoors.
- D. The minimum sealed combustion air duct size for each boiler is eight-inch diameter.
- E. Common vent and common combustion air must be an available option for boiler installation. Consult manufacturer for common vent and combustion air sizing.
- F. Follow guidelines specified in manufacturer's venting guide.

#### **2.06 SOURCE QUALITY CONTROL**

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.

- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
  - 1. If boilers are not factory assembled and fire-tested, the local vendor is responsible for all field assembly and testing.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect fourteen days in advance of testing.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Before boiler installation examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations and piping and electrical connections to verify actual locations, sizes and other conditions affecting boiler performance, maintenance and operations.
  - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 BOILER INSTALLATION**

- A. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

#### **3.03 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to boiler to permit service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Boiler Venting
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect venting full size to boiler connections.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
  - 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.
- B. Tests and Inspections
  - 1. Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Perform hydrostatic test. Repair leaks and retest until no leaks exist.
  - 3. Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests:
- F. The boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the boiler manufacturer to complete the following performance tests:
  - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
  - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
  - 3. Perform field performance tests to determine capacity and efficiency of boilers.
    - a. Test for full capacity.
    - b. Test for boiler efficiency at low fire, 20, 40, 60, 80, 100, 80, 60, 40 and 20 percent of full capacity. Determine efficiency at each test point.
  - 4. Repeat tests until results comply with requirements indicated.
  - 5. Provide analysis equipment required to determine performance.
  - 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
  - 7. Notify Architect in advance of test dates.
  - 8. Document test results in a report and submit to Architect.

**END OF SECTION**



**SECTION 23 64 26**  
**VARIABLE SPEED AIR COOLED SCREW WATER CHILLERS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Chiller package.
- B. Charge of refrigerant and oil.
- C. Controls and control connections.
- D. Chilled water connections.
- E. Starters.
- F. Electrical power connections.

**1.02 REFERENCES**

- A. AHRI 550/590 - Standard for Water Chilling Packages using the Vapor Compression Cycle.
- B. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment.
- C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- D. ANSI/ASHRAE 90.1 - Energy Efficient Design of New Buildings.
- E. ANSI/ASME - Boiler and Pressure Vessel Code SEC VIII, Division 1.
- F. UL 1995 - Central Cooling Air Conditioners.
- G. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings.
- H. IASTM B117 - Standard Method of Salt Spray (Fog) Testing
- I. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- J. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products
- K. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments

**1.03 SUBMITTALS**

- A. Submit dimensional plan and elevation view drawings, weights and loadings, required clearances, location and size of all field connections, electrical requirements and wiring diagrams.
- B. Submit product data indicating rated capacities, specialties and accessories.
- C. Submit manufacturer's installation instructions.

**1.04 OPERATION AND MAINTENANCE DATA**

- A. Submit operation data.
- B. Include start-up instructions, maintenance data, controls, and accessories.
- C. Submit maintenance data.

**1.05 REGULATORY REQUIREMENTS**

- A. Conform to AHRI 550/590-2011 Standard for testing and certified rating of Water Chilling Packages using the Vapor Compression Cycle.

- B. Conform to ANSI/UL 1995 code for construction of water chillers. In the event the unit is not UL approved, the manufacturer shall, at manufacturer expense, provide for a field inspection by an UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative.
- C. Conform to ANSI/ASME Boiler and Pressure Vessel Code SEC 8 for construction and testing of water chillers.
- D. Conform to ANSI/ASHRAE 15 code for construction and operation of water chillers.
- E. Chiller must be built in an ISO 9001 classified facility.

#### **1.06 VERIFICATION OF CAPACITY, EFFICIENCY AND OPERATION**

- A. All proposals for chiller performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI.
- B. Factory Ambient Controlled Performance Test: The chiller (one of each size) shall be factory performance tested in an ambient controlled, AHRI 550/590 approved test facility. The manufacturer shall supply a certified test report to confirm performance as specified. Proper AHRI certification documents for the test loop shall be made available upon request from the manufacturer for inspection. The performance test shall be conducted in accordance with AHRI Standard 550/590 procedures and tolerances.
  - 1. The test shall be conducted at design conditions.
  - 2. The following allowable tolerances must be referenced:
    - a. The tolerance on capacity shall be as defined by AHRI Standard 550/590 for full and part load points.
    - b. The tolerance on efficiency shall be defined by AHRI Standard 550/590 for IPLV/NPLV, full load and all part load test points.
  - 3. The performance test shall be run with clean tubes in accordance with AHRI Standard 550/590 to include the following:
    - a. A downward temperature adjustment shall be made to the design leaving evaporator water temperature to adjust from the design fouling to the clean tube condition.
  - 4. The factory test instrumentation shall be per AHRI Standard 550/590, and the calibration of all instrumentation shall be traceable to the National Institute of Standards and Technology (formerly NBS).
  - 5. The owner or his representative shall be notified 14 days in advance to witness the factory performance test. If the owner or his representative desires to witness the performance test, all travel expenses will be the owner's responsibility.
  - 6. A certified test report of all data shall be submitted to the Contracting Officer prior to completion of the project. The factory certified test report shall be signed by an officer of the manufacturer's company. Preprinted certification will not be acceptable; certification shall be in the original.

#### **1.07 STORAGE AND HANDLING**

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Unit controls shall be capable of withstanding 203 F (95 C) storage temperatures in the control compartment for an indefinite period of time.

## **1.08 WARRANTY**

- A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.
- B. A 5-year motor/transmission/compressor warranty shall be provided.

## **PART 2 PRODUCTS**

### **2.01 SUMMARY**

- A. The contractor shall furnish and install air-cooled water chillers as shown as scheduled on the contract documents. The chillers shall be installed in accordance with this specification and perform at the specified conditions as scheduled.
- B. The contractor shall furnish and install air-cooled rotary liquid chiller of size and capacity scheduled. Unit shall be installed in strict accordance with this specification. All units shall be furnished complete with semi-hermetic helical rotary compressors, shell and tube evaporator, air-cooled condenser, electronic expansion valves and microprocessor control panel. Total unit shall be UL certified and include the UL label. The unit shall be designed for outdoor application. The unit shall be rated in accordance with AHRI Standard 550/590.
- C. Factory Functional Test: The chiller shall be pressure tested, evacuated and fully charged with R134a refrigerant and oil. In addition, a factory functional test shall be conducted to verify correct operation by cycling condenser fans and compressors and confirmation operation of temperature and pressure sensors.

### **2.02 COMPRESSORS**

- A. Construct chiller using semi-hermetic, direct-drive, helical rotary screw compressors with capacity control via a variable speed drive and independent circuits.
- B. Provide oil lubrication system with oil charging valve and oil filter to ensure adequate lubrication during starting, stopping, and normal operation.
- C. Provide compressor with automatic capacity reduction equipment consisting of a capacity control variable speed drive. The controls system logic must decelerate the compressor to minimum speed for a soft start.
- D. Provide direct-drive compressor motor that is suction gas cooled with robust construction and system design protection. Compressor starter shall be a variable speed drive to provide a soft start. Compressor without variable speed drive shall be provided with a wye-delta or solid state starter for reduced inrush current upon starting.
- E. Provide compressor heater to evaporate refrigerant returning to compressor during shut down. Energize heater when compressor is not operating.

### **2.03 EVAPORATOR**

- A. The evaporator shall be designed, tested, and stamped in accordance with ASME code for a refrigerant side working pressure of 200 psig. Waterside working pressure shall be 150 psig.
- B. Insulate the evaporator with a minimum of K=0.28 UV rated insulation. If the insulation is field installed, the additional money to cover material and installation costs in the field should be included in the bid.
- C. Evaporator heaters shall be factory installed and shall protect unit down to -20 F. Contractor shall wire separate power to energize heat tape and protect cooler while chiller is disconnected from the main power.

- D. Provide shell and tube type evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally and externally finned copper tubes, roller expanded into tube sheets.
- E. Provide ability to remove evaporator tubes from either end of the heat exchanger.
- F. Provide water drain connection, vent and fittings for factory installed leaving water temperature control and low temperature cutout sensors.
- G. Water connections shall be grooved pipe. Evaporator shall have only one entering and one leaving connection. If manufacturer provides 2 separate evaporators, contractor shall provide manifold and pressure gauges to ensure equal flow is provided to each evaporator.
- H. Proof of flow shall be provided by the equipment manufacturer, mechanically installed and electrically wired, at the factory of origin.

#### **2.04 CONDENSER AND FANS**

- A. Low Sound Fans shall be dynamically and statically balanced, direct-drive, corrosion resistant, glass fiber reinforced composite molded into a low noise fan blade.
- B. Chiller shall be able to start and operate in ambient conditions down to 0F (-17.8C) with glycol, and up to 105F (40.6C). Low ambient operation is accomplished with variable frequency drives on the condenser fans and control logic.
- C. Construct condenser coils of aluminum fins mechanically bonded to internally finned long life tube alloy. The condenser coils shall have an integral subcooling circuit and shall be designed for 525 psig or higher working pressure.
- D. Provide factory installed louvered "architecturally pleasing" guard panels. Panel louvers shall cover condenser, evaporator and compressor sections so all are hidden from sight. Wire screens or wire mesh will not be allowed.

#### **2.05 ENCLOSURES/STARTER**

- A. House components in a galvanized steel frame and mounted on a formed steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc. (UL) recognized as G90-U, UL guide number DTHW2.
- B. Unit panels, base rails and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment of Federal Government Agencies.
- C. Mount starters and Terminal Blocks in a UL 1995 rated weatherproof panel provided with full opening access doors. The circuit breaker is to be a lockable, through-the-door type with an operating handle and clearly visible from outside of unit indicating if power is on or off.
- D. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A 123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B 117. Each specimen shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, the coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. The rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8 inch). The rating of the unscribed area shall not be less than ten (no failure). Thickness of coating or paint system on the actual equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness. For each compressor provide a variable speed

drive starter. Across-the-line and Delta-Delta shall be unacceptable. If a variable speed drive starter is not applicable, wye-delta or solid state starter must be provided.

- E. A control power transformer shall be factory-installed and factory-wired to provide unit control power.

## **2.06 VARIABLE SPEED DRIVE**

- A. The water chiller shall be furnished with a variable speed drive (VSD) to minimize maintenance and maximize cooling efficiency. The VSD shall be factory mounted on the chiller and shipped completely factory assembled, wired and tested.
- B. The VSD will be specifically designed to interface with the water chiller controls and allow for the operating ranges and specific characteristics of the chiller. The VSD control logic shall optimize chiller efficiency by coordinating compressor motor speed to maintain the chilled water setpoint.
- C. The VSD efficiency shall be 95% or better at full speed and full load. Fundamental displacement power factor shall be a minimum of 0.95.
- D. The VSD shall be solid state, microprocessor based pulse-width modulated (PWM) design. The VSD shall be voltage and current regulated. Output power devices shall be IGBT transistors.
- E. Power semi-conductor and capacitor cooling shall be from a liquid cooled heatsink.
- F. The VSD shall have thin film capacitors.
  - 1. If thin film capacitors are not factory provided, then manufacturer should include a 5 year warranty on the drive.
- G. The VSDs shall each be furnished in a UL 1995 rated metal enclosure having as minimum a short circuit withstand rating of 65,000 amps. It will include three phase input lugs plus a grounding lug for electrical connections, output motor connection via factory installed bus bars and all components properly segregated and completely enclosed in a single metal enclosure.
  - 1. Enclosure shall include a padlockable, door-mounted circuit breaker with shunt trip and AIC rating of 65,000 amps.
  - 2. The entire chiller package shall be UL/CUL listed.
- H. The following VSD status indicators shall be available to facilitate startup and maintenance:
  - 1. Output speed in hertz and rpm
  - 2. Input line voltage
  - 3. Input line kW
  - 4. Output/load amps
  - 5. Average current in percent RLA
  - 6. Load power factor
  - 7. Fault
  - 8. VSD transistor temperature
- I. The VSD shall include the following features:
  - 1. All control circuit voltages are physically and electrically isolated from power circuit voltage.
  - 2. Soft start, adjustable linear acceleration, coast-to-stop.

3. Adjustable current limiting and UL approved electronic motor overload protection.
  4. Insensitivity to incoming power phase sequence.
  5. VSD and motor protection from the following faults:
    - a. Output line-to-line short circuit protection
    - b. Line-to-ground short circuit protection
    - c. Phase loss at AFD input
    - d. Phase reversal / Imbalance
    - e. Over-voltage / Under-voltage
    - f. Over temperature
- J. Warranties
1. The variable speed drive shall be warranted by the manufacturer for a period of twelve months from the date of installation. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory-authorized on-site service.

## **2.07 REFRIGERANT CIRCUIT**

- A. All units shall have 2 refrigeration circuits to provide redundancy, each with one or two (manifolded) compressor(s) on each circuit.
- B. Provide for refrigerant circuit:
  1. Liquid line shutoff valve.
  2. Suction service valve
  3. Filter (replaceable core type).
  4. Liquid line sight glass.
  5. Electronic expansion valve sized for maximum operating pressure.
  6. Charging valve.
  7. Discharge and oil line check valves.
  8. High side pressure relief valve.
  9. Full operating charge of HFC-134a and oil.
- C. Capacity Modulation: Provide capacity modulation by a variable speed drive. Unit shall be capable of operation down to 20%.

## **2.08 CONTROLS**

- A. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer. Controls shall include the following readouts and diagnostics:
  1. Phase reversal/unbalance/single phasing and over/under voltage protection.
  2. Low chilled water temperature protection.
  3. High and low refrigerant pressure protection.
  4. Load limit thermostat to limit compressor loading on high return water temperature.

5. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize unit efficiency.
  6. Display diagnostics.
  7. Oil pressure control based off of maintaining system differential pressure.
  8. Compressors: Status (on/off), %RLA, anti-short cycle timer, and automatic compressor lead-lag.
- B. On chiller, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer and a single 115 volt 60 Hz single phase connection for evaporator freeze protection heaters.
1. The unit controller shall utilize a microprocessor that will automatically take action to prevent unit shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.
- C. In the above case, the chiller will continue to run in an unloaded state, and will continue to produce some chilled water in an attempt to meet the cooling load. However, if the chiller reaches the trip-out limits, the chiller controls will take the chiller off line for protection, and a manual reset will be required. Once the "near-trip" condition is corrected, the chiller will return to normal operation and can then produce full load cooling.
- D. Provide the following safety controls with indicating lights or diagnostic readouts.
1. Low chilled water temperature protection.
  2. High refrigerant pressure.
  3. Low oil flow protection.
  4. Loss of chilled water flow.
  5. Contact for remote emergency shutdown.
  6. Motor current overload.
  7. Phase reversal/unbalance/single phasing.
  8. Over/under voltage.
  9. Failure of water temperature sensor used by controller.
  10. Compressor status (on or off).
- E. Provide the following operating controls:
1. A variable method to control capacity in order to maintain leaving chilled water temperature based on PI algorithms. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included, hot gas bypass shall be provided to insure accurate chilled water temperature control in light load applications.
  2. Chilled water pump output relay that closes when the chiller is given a signal to start.
  3. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip outs.

4. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.
  5. Compressor current sensing unloader unit that unloads compressors to help prevent current overload nuisance trip outs.
  6. Auto lead-lag functions that constantly even out run hours and compressor starts automatically. If contractor cannot provide this function then cycle counter and hour meter shall be provided for each compressor so owner can be instructed by the contractor on how to manually change lead-lag on compressors and even out compressor starts and running hours.
  7. Low ambient lockout control with adjustable setpoint.
  8. Condenser fan sequencing which adjusts the speed of all fans automatically in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.
- F. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:
1. Leaving chilled water setpoint adjustment from LCD input
  2. Entering and leaving chilled water temperature output
  3. Percent RLA output for each compressor
  4. Pressure output of condenser
  5. Pressure output of evaporator
  6. Ambient temperature output
  7. Voltage output
  8. Current limit setpoint adjustment from LCD input.

## 2.09 SOUND

- A. Chiller sound pressure shall not exceed the following A-weighted dBA as measured 30 feet from the side of the unit:

A-weighted sound pressure (dBA)	70
A-weighted 75% sound pressure (dBA)	64
A-weighted 50% sound pressure (dBA)	57
A-weighted 25% sound pressure (dBA)	56

- B. Submitted sound data shall be in accordance with AHRI 370.
1. If manufacturer cannot meet this sound specification then sound attenuation devices and/or barrier walls must be field installed at the contractor's expense to meet the specified level.



## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Align chiller package on steel or concrete foundations.
- C. Install units on level base and optional vibration isolators.
- D. Connect to electrical service.
- E. Connect to chilled water piping.
- F. Arrange piping for easy dismantling to permit tube cleaning.

### **3.02 MANUFACTURER'S FIELD SERVICES**

- A. OEM Startup is performed by factory trained and authorized servicing technicians confirming equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty.
  - 1. Included in OEM Factory Startup:
    - a. Centrifugal and Rotary Screw/Scroll Chillers
- B. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

**END OF SECTION**



## **SECTION 23 73 13**

### **CENTRAL STATION AIR HANDLER**

#### **PART 1 GENERAL**

##### **1.01 WORK INCLUDED**

- A. Applied Air Handling Units.

##### **1.02 RELATED SECTIONS**

- A. Section 23 0900 - Building Automation and Control Systems

##### **1.03 REFERENCES**

- A. AMCA Publication 99 - Standards Handbook.
- B. AMCA Publication 611 - Certified Ratings Program - Airflow Measurement Performance
- C. AMCA Standard 500-D - Laboratory Methods of Testing Dampers for Rating.
- D. ANSI/ABMA Standard 9 - Load Ratings and Fatigue Life for Ball Bearings.
- E. ANSI/AMCA Standard 204 - Balance Quality and Vibration Levels for Fans.
- F. ANSI/AMCA Standard 610 - Laboratory Methods of Testing Airflow Measuring Stations for Rating.
- G. ANSI/AHRI Standard 410 - Forced Circulation Air-Cooling and Air-Heating Coils.
- H. ANSI/AHRI Standard 430 - Central Station Air Handling Units.
- I. ANSI/AHRI Standard 1060 - Rating Air-To-Air Energy Recovery Ventilation Equipment
- J. ANSI/ASHRAE Standard 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- K. ANSI/ASHARE Standard 62.1 - Ventilation for Acceptable Indoor Air Quality.
- L. ANSI/ASHARE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- M. ANSI/NEMA MG 1 - Motors and Generators.
- N. ANSI/UL 900 - Standard for Safety Air Filter Units.
- O. AHRI Standard 260 - Sound rating of Ducted Air Moving and Conditioning Equipment.
- P. ASHRAE Standard 84 - Method of Testing Air-to-Air Heat Exchangers.
- Q. ASHRAE Standard 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
- R. ASTM B117 - Standard Practice for Operation Salt Spray Apparatus.
- S. ASTM E477 - Standard Test Method for Measure Acoustical and Airflow Performance of Duct Liner
- T. NFPA 70 - National Electrical Code
- U. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilation Systems.
- V. UL 1995 - Standard for Safety Heating and Cooling Equipment

##### **1.04 QUALITY ASSURANCE**

- A. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current AHRI Standard 410.

- B. Air handling units with fan sections utilizing single fans shall be rated and certified in accordance with AHRI Standard.
- C. Air handling units with fan sections utilizing multiple fans shall be rated in accordance with AHRI Standard 430 for airflow, static pressure, and fan speed performance.
- D. Airflow monitoring station: Certify airflow measurement station performance in accordance with AMCA 611.

#### **1.05 SUBMITTALS**

- A. No equipment shall be fabricated or delivered until the receipt of approved shop drawings from the Owner or Owner's approved representative.
- B. AHU manufacturer shall provide the following information with each shop drawing/product data submission:
  - 1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.
  - 2. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
  - 3. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.
  - 4. All performance data, including capacities and airside and waterside pressure drops, for components.
  - 5. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.
  - 6. For units utilizing multiple fans in a fan section, a fan curve shall be provided showing the performance of the entire bank of fans at design conditions. In addition, a fan curve shall be provided showing the performance of each individual fan in the bank of fans at design conditions. Also a fan curve shall be provided showing the performance of the bank of fans, if one fan is down. The percent redundancy of the bank of fans with one fan down shall be noted on the fan curve or in the tabulated fan data.
  - 7. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.
  - 8. An electrical MCA - MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description, voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and calculated Maximum Overcurrent Protection (MOP).
  - 9. Sound data shall be provided using AHRI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000 and 8000Hz.

- C. The AHU manufacturer shall provide appropriate sets of submittals as referenced in the General Conditions and shall submit to the Owner electronic copies of the IOM.
- D. The AHU manufacturer shall list any exceptions to the specification.

#### **1.06 REGULATOR REQUIREMENTS**

- A. Agency Listings/Certifications
  - 1. Unit shall be manufactured to conform to UL 1995 and shall be listed by either UL/CUL or ETL. Units shall be provided with listing agency label affixed to the unit. In the event the unit is not UL/CUL or ETL approved, the contractor shall, at his/her expense, provide for a field inspection by a UL/CUL or ETL representative to verify conformance. If necessary, contractor shall perform modifications to the unit to comply with UL/CUL or ETL as directed by the representative, at no additional expense to the owner.
  - 2. Air handling units with multiple direct drive plenum fans, or direct drive plenum fans incorporated with ECM style motors are outside the scope of AHRI 430. These fans however are rated in accordance with AHRI 430.
  - 3. Certify air handling units in accordance with AHRI Standard 430. Units shall be provided with certification label affixed to the unit. If air handling units are not certified or fans are not rated in accordance with AHRI Standard 430 contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.
  - 4. Certify air handling coils in accordance with AHRI Standard 410. Units shall be provided with certification label affixed to the unit. If air handling coils are not certified in accordance with AHRI Standard 410, contractor shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the contractor.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. Each section shall have lifting lugs for field rigging, lifting and final placement of AHU section(s). AHU's less than 100-inches wide shall allow for forklift transport and maneuverability on the jobsite.
- C. Deliver units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.
- D. Unit shall be shipped in a clear shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.
- E. Installing contractor shall be responsible for storing AHU in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

## **1.08 START-UP AND OPERATING REQUIREMENTS**

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

## **1.09 WARRANTY**

- A. AHU manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

## **PART 2 PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Approved manufacturer shall be Trane, with pre-approved alternates considered. Manufacturers not pre-approved, must obtain pre-approval in writing from consulting engineer prior to bid. Alternates must comply with all performance and features as called for in this specification. Job awarded on basis of specified equipment. Alternate will be evaluated and considered after job is awarded.
- B. Manufacturer must clearly define any exceptions made to Plans and Specifications. Any deviations in layout or arrangement shall be submitted to consulting engineer prior to bid date. Acceptance of deviation(s) from specifications shall be in the form of written approval from the consulting engineer. Mechanical Contractor is responsible for expenses that occur due to exceptions made.
- C. Approved Manufacturers:
  - 1. Trane
  - 2. Daikin Applied
  - 3. Temptrol

### **2.02 GENERAL**

- A. Unit layout and configuration shall be as defined in project plans and schedule.
- B. Manufacturer to provide a full perimeter integral base frame for either ceiling suspension of units or to support and raise all sections of the unit. Base frame will either be bolted construction or welded construction. Refer to schedule for base height and construction type. Contractor will be responsible for providing a housekeeping pad when unit base frame is not of sufficient height to properly trap unit. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel. Unit base height to be included in total height required for proper trap height.

### **2.03 UNIT CASING**

- A. Unit manufacturer shall ship unit in segments as specified by the contractor for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full

perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.

- B. Casing performance - Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft<sup>2</sup> of casing surface area) = CL X P<sup>0.65</sup>. A written factory test report is to be provided verifying the specified ASHRAE 111 leak class 6 has been met.
- C. Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.
- D. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g., whichever is less, and shall not exceed 0.0042 per inch of panel span (L/240).
- E. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042 per inch of panel span.
- F. Unit casing panels shall be 2-inch double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.
- G. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr\*Ft<sup>2</sup>\*°F/BTU.
- H. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.
- I. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.
- J. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.
- K. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

#### **2.04 ACCESS DOORS**

- A. Access doors shall be 2-inch double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.
- B. All doors downstream of the cooling coil shall be provided with a thermal break construction of door panel and door frame.
- C. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.
- D. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.
- E. Handle hardware shall be designed to prevent unintended closure.
- F. Access doors shall be hinged and removable without the use of specialized tools.

- G. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.
- H. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.
- I. All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.
- J. Multiple door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.
- K. An optional shatterproof window shall be provided in access doors where indicated on the plans. Window shall either be single pane, or thermal dual pane, as defined on schedule. Window shall be capable of withstanding unit operating pressures and shall be safe for viewing UV-C lamps.

## **2.05 PRIMARY DRAIN PANS**

- A. All cooling coil sections shall be provided with an insulated, double-wall, stainless steel drain pan.
- B. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements. See section 2.07, paragraph F through H for specifications on intermediate drain pans between cooling coils.
- C. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- D. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.
- E. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.
- F. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.
- G. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.
- H. If drain pans are required for heating coils, access sections, or mixing sections they will be indicated in the plans.

## **2.06 FANS**

- A. Fan sections shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components. Construct door(s) per Section 2.04.
- B. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment



- as an assembly at the operating RPM to meet design specifications. Fans that are selected with inverter balancing shall first be dynamically balanced at design RPM. The fans then will be checked in the factory from 25% to 100% of design RPM to insure they are operating within vibration tolerance specifications, and that there are no resonant frequency issues throughout this operating range. Inverter balancing that requires lockout frequencies inputted into a variable frequency drive in order to bypass resonant frequencies shall not be acceptable. If supplied in this manner by the unit manufacturer, the contractor will be responsible for rebalancing in the field after unit installation. Fans selected with inverter balancing shall have a maintenance free, circumferential conductive micro fiber shaft grounding ring installed on the fan motor to discharge shaft currents to ground.
- C. Belt-driven fans shall be provided with grease lubricated, self-aligning, anti-friction bearings selected for L-50 200,000-hour average life per ANSI/AFBMA Standard 9. Lubrication lines for both bearings shall be extended to the drive side of the AHU and rigidly attached to support bracket with zerk fittings. Lubrication lines shall be a clear, high-pressure, polymer to aid in visual inspection. If extended lubrication lines are not provided, manufacturer shall provide permanently lubricated bearing with engineering calculations for proof of bearing life.
  - D. Fans, including belt driven and direct drive plenum fans with integral frame motors, shall be mounted on isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with spring isolators. A flexible connection shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.
  - E. Fan airflow measurement systems shall be provided as indicated on the schedule and drawings to measure fan airflow directly or to measure differential pressure that can be used to calculate airflow. The accuracy of the devices shall be no worse than +/- 5 percent when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with selectable 4-20 mA or 2-10 VDC output. Signal shall be proportional to air velocity.
  - F. Each direct drive fan in a multiple-fan array shall be provided with integral back flow prevention: a backdraft damper that prohibits recirculation of air in the event a fan or multiple fans become disabled. Dampers are tested and rated based on AMCA Standard 500. Dampers to be heavy duty type capable of a maximum back pressure that exceeds the design total static pressure with minimal leakage. The dampers should have a minimal total effect on airflow performance, both pressure drop when open and system effect on the fan. The damper blades and frame shall be extruded aluminum with blade edge seals locked into the blade edge. Adhesive type seals are unacceptable. AHU manufacturer responsible for providing proper spacing upstream of dampers to ensure full, uniform airflow through upstream components. For units where the damper(s) are supplied at the jobsite, the installing contractor shall contract a certified TAB contractor to verify uniform airflow thru upstream components.

## G. MOTORS AND DRIVES

1. All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change. Fan sections without factory-installed motors shall have motors field installed by the contractor. The contractor shall be responsible for all costs associated with installation of motor and drive, alignment of sheaves and belts, run testing of the motor, and balancing of the assembly.
2. Motors shall meet or exceed all NEMA Standards Publication MG 1 - 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
3. Fan Motors shall be heavy duty, open drip-proof operable at 460 volts, 60Hz, 3-phase. If applicable, motor efficiency shall meet or exceed NEMA Premium efficiencies.
4. Belt driven fans shall use 4-pole, 1800 rpm, motors, NEMA B design, with Class B insulation, capable to operate continuously at 104 deg F (40 deg C) without tripping overloads.
5. Direct driven fans utilizing integral frame motors shall use 2-pole (3600 rpm), 4-pole (1800 rpm) or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation capable to operate continuously at 104 deg F (40 deg C) without tripping overloads.
6. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.
7. V-Belt Drive shall be fixed pitch rated at 1.5 times the motor nameplate. Drives 20 hp and larger or any drives on units equipped with VFDs shall be fixed pitch.

## 2.07 COILS

- A. Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.
- B. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.
- C. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or finning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
- D. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
- E. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.

- F. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the sections primary drain pan.
- G. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.
- H. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- I. Hydronic Coils
  - 1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
  - 2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.
  - 3. Headers shall be constructed of round copper pipe or cast iron.
  - 4. Tubes shall be 1/2-inch .016 copper, with aluminum fins.
  - 5. Hydronic coils shall be supplied with factory installed drain and vent piping to the unit exterior.

## **2.08 FILTERS**

- A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Construct doors in accordance with Section 2.04. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement. Filters to be of size, and quantity needed to maximize filter face area of each particular unit size.
- B. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedule
- C. Manufacturer shall provide one set of startup filters.
- D. Each filter section shall be provided with a factory-installed, flush-mounted Dwyer dial-type differential pressure gauge piped to both sides of the filter to indicate status. Gauge shall maintain a +/- 5 percent accuracy within operating temperature limits of -20°F to 120°F. Filter sections consisting of pre- and post-filters shall have a gauge for each.

## **2.09 DAMPERS**

- A. All dampers, with the exception of external bypass and multizones (if scheduled), shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge

complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

- B. Airflow measuring stations shall be provided and located in the outside air paths as indicated on the schedule and plans to measure airflow. Airflow measuring stations shall be tested per AMCA Standard 611 and licensed to bear the AMCA Ratings Seal for airflow measurement performance. Integral control damper blades shall be provided as galvanized steel and housed in a galvanized steel frame. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage.
  - 1. The airflow measurement station shall measure up to 100 percent of the total outside air. The airflow measurement station shall be capable of measuring down to 300 fpm. The airflow measuring device shall adjust for temperature variations. Output shall be provided from the station as a 2-10 VDC signal. Signal shall be proportional to air velocity. The accuracy of the measuring station shall be no greater than +/- 5 percent. Airflow measuring stations shall be mounted on the AHU interior.

## **2.10 ACCESS SECTIONS**

- A. Access sections shall be provided where indicated in the schedule and plans to allow additional access for inspection, cleaning, and maintenance of unit components. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be provided in the AHU manufacturer's maintenance manual. Access section doors shall be constructed per Section 2.04.

## **2.11 STEAM DISPERSION HUMIDIFICATION SECTION**

- A. Humidifier sections shall be provided within the air handling unit with the appropriate humidifier type and performance as indicated on the schedule and drawings.
- B. Humidifiers shall consist of a dispersion panel with a steam supply header/separator and a bank of steam dispersion tubes. Each active tube shall be fitted with a series of nozzles which extend from the center of the tube. The nozzles shall be sized and spaced to accept steam from the separator/header and provide a dry and uniform discharge of steam. All wetted tubes and headers shall be stainless steel.
- C. No component shall be located upstream of the humidifier within 8 inches or downstream of the humidifier within an absorption distance of 18 inches.
- D. All pipe connections shall be made from one side of the air handler as indicated on the schedule and drawings.
- E. For direct steam applications, the control valve shall be protected by a steam supply strainer and inverted bucket trap. Steam separators, control valves, traps, and strainers shall be provided by the AHU Manufacturer and shipped loosed for field installation.

## **2.12 MARINE LIGHTS**

- A. Marine lights shall be provided throughout AHUs as indicated on the schedule and plans. Lights shall be instant-on, light-emitting diode (LED) type to minimize amperage draw and shall produce lumens equivalent to a minimum 75W incandescent bulb (1200 lumens). LED lighting shall provide instant-on, white light and have a minimum 50,000 hr life.

- B. Light fixture shall be weather-resistant, enclosed and gasketed to prevent water and dust intrusion.
- C. Fixtures shall be designed for flexible positioning during maintenance and service activities for best possible location providing full light on work surface of interest and not being blocked by technician.
- D. All lights on a unit shall be wired in the factory to a single on-off switch.
- E. Installing contractor shall be responsible for providing 115V supply to the factory-mounted marine light circuit (unless single-point power is specified to be provided by AHU manufacturer).

### **2.13 CONVENIENCE OUTLETS**

- A. A 15-amp, 115V GFCI convenience outlet shall be provided by the AHU manufacturer. The outlet shall be separate from the load side of the equipment per NEC requirements. Installing contractor shall be responsible for providing 115V supply to the factory-mounted GFCI outlet circuit per NEC (even when single-point power is specified to be provided by AHU manufacturer).

### **2.14 VARIABLE FREQUENCY DRIVES (VFDs)**

- A. Variable frequency drives shall be provided, mounted and wired by the AHU manufacturer as indicated on the schedule and drawings. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. The VFDs shall be UL listed. The listing shall allow mounting in plenum or other air handling compartments.
- B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.
- C. With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
- D. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- E. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL 508 certified for the building and assembly of option panels. Assembly of separate panels with options by a third-party is not acceptable. The appropriate UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel.
- F. The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 3% impedance line reactor.
- G. The VFDs full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.

- H. The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.
- I. An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.
- J. Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.
- K. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.
- L. Galvanic and/or optical isolation shall be provided between the VFDs power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.
- M. The VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.
- N. Protective Features
  - 1. Protection shall be provided against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, undervoltage, VFD overtemperature and motor overtemperature. The VFD shall display all faults as words. Codes are not acceptable.
  - 2. The VFD shall be protected from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD shall continue to operate with reduced output with an input voltage as low as 164 V AC for 208/230 volt units, 313 V AC for 460 volt units, and 394 volts for 600 volts units.
  - 3. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
  - 4. The VFD package shall include semi-conductor rated input fuses to protect power components.
  - 5. To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Otherwise the AHU manufacturer shall ensure that inverter rated motors are supplied.
  - 6. The VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.
  - 7. The VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.
  - 8. The VFD shall catch a rotating motor operating forward or reverse up to full speed.
  - 9. The VFD shall be rated for 100,000 amp interrupting capacity (AIC).

10. The VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD shall identify which of the output phases is low or lost.
11. The VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt units, 539 V AC on 460 volt units, and 690 volts on 600 volt units.

O. Interface Features

1. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference. On units with bypass, a VFD/Off/Bypass selector switch shall be provided.
2. The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.
3. The VFD shall provide digital manual speed control. Potentiometers are not acceptable.
4. A lockable, alphanumeric backlit display keypad shall be provided. The keypad shall be remotely mountable up to 10 feet away using standard 9-pin cable.
5. The keypads for all sizes of VFDs shall be identical and interchangeable.
6. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFDs keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.
7. The display shall be programmable to display in English, Spanish and French at a minimum.
8. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
9. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.
10. The VFD shall include a standard EIA-485 communications port and capabilities to be connected at to the building FMS system. The connection shall be software selectable by the user.
11. At a minimum, the following points shall be controlled and/or accessible:
  - a. VFD Start/Stop
  - b. Speed reference
  - c. Fault diagnostics
  - d. Meter points
12. Four additional Form C 230 volt programmable relays shall be available for field installation within the VFD
13. Two set-point control interfaces (PID control) shall be standard in the unit. The VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
14. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

15. Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFDs unable to show these four displays simultaneously shall provide panel meters.
16. Sleep mode shall be provided to automatically stop the VFD when its speed drops below set  $\xi$ sleep $\xi$  level for a specified time. The VFD shall automatically restart when the speed command exceeds the set  $\xi$ wake $\xi$  level.
17. The sleep mode shall be functional in both follower mode and PID mode.
18. A run permissive circuit shall be provided to accept a system ready signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
19. The following displays shall be accessible from the control panel in actual units: Reference Signal Value, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and unit CFM.
20. The display shall be programmed to read in inches of water column (in-wg).
21. The VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
22. If the temperature of the VFDs heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFDs heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
23. The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.
24. The VFD shall store in memory the last 10 faults and related operational data.
25. Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
26. Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.
27. Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.
28. Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24V DC status indication.
29. Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.

P. Adjustments

1. The VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.
2. A minimum of sixteen preset speeds shall be provided.



3. Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.
4. Four current limit settings shall be provided.
5. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit and inverter overload.
6. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
7. An automatic on delay shall be selectable from 0 to 120 seconds.

Q. Service Conditions

1. VFDs shall provide full output in an ambient temperature from -10 to 50°C (14 to 104°F).
2. VFDs shall provide full output in a relative humidity from 0 to 95%, non-condensing.
3. VFDs shall provide full output up to 3,300 feet elevation without derating.
4. VFDs shall provide full output with an AC line voltage variation from -10 to +10% of nominal voltage.
5. No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

R. Warranty

1. The VFD shall be warranted by the manufacturer for a period of 42 months from date of shipment, or 36 months from start-up, which ever occurs first. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory-authorized on-site service.

**2.15 FACTORY-INSTALLED MOTOR WIRE TERMINATION, VFD, AND COMBINATION STARTER/DISCONNECT ENCLOSURES**

- A. VFDs shall be factory mounted on the drive side of the fan section. VFD may be mounted on the interior of the unit, accessible from the unit exterior through an access door, or on the casing exterior in a NEMA Type 1 enclosure for indoor units. If not mounted on the fan section due to NEC disconnect height limitations or serviceability constraints in the mechanical equipment room, VFD may be mounted in another location other than the fan.
- B. Any welds shall be properly finished with no rough edges. Enclosures shall house circuit breaker disconnects, bypass circuitry, Drive-OFF-Bypass switches, manual speed controls, and control transformers. VFDs and starter/disconnects shall have an external disconnect located on the outside of the access door.

**2.16 MOTOR OVERLOAD PANEL FOR FAN ARRAYS**

- A. A motor overload panel provides a single unit mounted UL508A listed control panel with all fans in an array pre-wired to it, such that one properly sized VFD may be field connected with no additional provisions required for protection of the individual motors. The control panel enclosure will be mounted on the exterior of the fan section and will be NEMA type 1 for indoor units and NEMA type 4 for outdoor units. A single power distribution block shall be provided for connection of the field mounted VFD with one conductor per phase. An electronic motor overload protector with lockable

manual isolation switch shall be provided for each motor in the array. Each motor in the array shall be independently grounded with a dedicated green conductor. A minimum of one open ground lug per fan plus one shall be provided for field use. Each motor overload protector shall be provided with an auxiliary contact and all auxiliary contacts will be wired in series to a terminal block for generic trip signaling. The panel will be rated for WYE power systems up to 600V.

## **2.17 FACTORY WIRING OF LIGHTS, VFDS, AND COMBINATION STARTERS/DISCONNECTS**

- A. VFDs shall be wired per NEC, UL, and NFPA 90A requirements. Units with factory-mounted controls shall also include power wiring from the VFD or starter/disconnect control transformer to the control system transformers. Units with VFDs and factory-mounted controls shall have a binary start-stop signal and an analog speed signal wired from the direct digital controller to the VFD.
- B. All power wiring for voltages greater than 24V and traveling through multiple unit sections shall be contained in an enclosed, metal, power-wiring raceway or EMT. Sections less than 6-inch in length may be contained in FMC.
- C. After mounting and wiring of VFDs, on the AHUs, trained factory personnel shall ensure proper operation of each VFD, through a thorough factory test. Testing shall include a Hypot test of unit wiring to ensure that no weaknesses exist in wiring or motor. Each VFD shall be energized and the fan run to ensure the VFD will operate throughout the usable range of the drive and that the fan rotation is correct. Each VFD with bypass shall also be tested in the bypass position to ensure the bypass is operational.
- D. For fan motors not supplied with a factory mounted and wired starter or VFD, the unit manufacturer shall supply a 4 X 4 NEMA 4 junction box on the exterior of the fan section(s) with wiring, prewired to the fan motor, to allow for ease of field installation of a starter or VFD.
- E. On units provided with factory mounted and wired supply fan starter or VFD and DDC controls, the manufacturer shall provide a single point of power. Line-to-24v transformers shall be provided with sufficient VA to power the unit mounted controller and factory installed control points.

## **PART 3 EXECUTION**

### **3.01 SHIPPING**

- A. Paper copies of the IOM shall also be shipped with each AHU.
- B. The AHU manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm the receipt of units when they are received. For parts too small to mark individually, the AHU manufacturer shall place them in containers.
- C. To protect equipment during shipment and delivery, all indoor units shall be completely stretch or shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment
- D. After loading the equipment for shipment, the AHU manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.

### **3.02 ON-SITE STORAGE**

- A. If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

### **3.03 FIELD EXAMINATION**

- A. The Mechanical Contractor shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.
- B. The Mechanical Contractor shall verify that the proper power supply is available prior to starting of the fans.

### **3.04 INSTALLATION**

- A. The Mechanical Contractor shall be responsible to coordinate ALL of his installation requirements with the Owner and the Owner's selected Mechanical Contractor to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or welded joints, and all other installation and assembly requirements.
- B. The AHU manufacturer shall provide all screws and gaskets for joining of sections in the field.
- C. The Mechanical Contractor shall verify that the following items have been completed prior to scheduling the AHU manufacturer's final inspection and start up:
  - 1. All spring-isolated components have had their shipping restraints removed and the components have been leveled.
  - 2. On all field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.
  - 3. All water and steam piping connections have been completed and hydrostatically tested and all water flow rates have been set in accordance with the capacities scheduled on the Drawings.
  - 4. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.
  - 5. All power wiring, including motor starters and disconnects, serving the unit has been completed.
  - 6. All automatic temperature and safety controls have been completed.
  - 7. All dampers are fully operational.
  - 8. All shipping materials have been removed.
  - 9. All (clean) filter media has been installed in the units.

### **3.05 LEVELING**

- A. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer's instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

### **3.06 FINAL INSPECTION AND START UP SERVICE**

- A. After the Mechanical Contractor has provided all water and steam piping connections, ductwork connections, and field control wiring, and Electrical Contractor has provided all the field power wiring, the Mechanical Contractor shall inspect the installation. The Mechanical Contractor shall then perform startup of the equipment.
- B. The Automatic Temperature Control (Building Direct Digital Control) Contractor shall be scheduled to be at the job site at the time of the equipment start up.
- C. The Mechanical Contractor, shall perform the following tests and services and submit a report outlining the results:
  - 1. Record date, time, and person(s) performing service.
  - 2. Lubricate all moving parts.
  - 3. Check all motor and starter power lugs and tighten as required.
  - 4. Verify all electrical power connections.
  - 5. Conduct a start up inspection per the AHU manufacturer's recommendations.
  - 6. Record fan motor voltage and amperage readings.
  - 7. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.
  - 8. Check fan for excessive vibration.
  - 9. Check V belt drive or coupling for proper alignment.
  - 10. Check V belt drive for proper tension. Tighten the belts in accordance with the AHU manufacturer's directions. Check belt tension during the second and seventh day's operation and re-adjust belts, as may be required, to maintain proper tension as directed by the AHU manufacturer.
  - 11. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.
  - 12. Disengage all shipping fasteners on vibration isolation equipment.
  - 13. Check safety guards to insure they are properly secured.
  - 14. Secure all access doors to the fan, the unit and the ductwork.
  - 15. Switch electrical supply "on" and allow fan to reach full speed.
  - 16. Physically check each fan at start up and shut down to insure no abnormal or problem conditions exist.
  - 17. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.
  - 18. Check all control sequences.

**END OF SECTION**

## **SECTION 23 82 39.13**

### **CABINET UNIT HEATERS**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

- A. Section includes cabinet unit heaters with centrifugal fans and hot-water coils.

##### **1.03 DEFINITIONS**

- A. CWP: Cold working pressure.
- B. DDC: Direct digital control.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

##### **1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include location and size of each field connection.
  - 4. Include details of anchorages and attachments to structure and to supported equipment.
  - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
  - 6. Indicate location and arrangement of piping valves and specialties.
  - 7. Indicate location and arrangement of integral controls.
  - 8. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.
- E. Samples for Verification: Finish colors for each type of cabinet unit heater indicated with factory-applied color finishes.

##### **1.05 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Structural members to which cabinet unit heaters will be attached.

3. Method of attaching hangers to building structure.
  4. Size and location of initial access modules for acoustical tile.
  5. Items penetrating finished ceiling, including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
  6. Perimeter moldings for exposed or partially exposed cabinets.
- B. Field quality-control reports.

#### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

#### **1.07 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Cabinet Unit-Heater Filters: Furnish one spare filter(s) for each filter installed.

### **PART 2 PRODUCTS**

#### **2.01 DESCRIPTION**

- A. Factory-assembled and -tested unit complying with AHRI 440.
- 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.
- C. Comply with UL 2021.

#### **2.02 PERFORMANCE REQUIREMENTS**

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

#### **2.03 CABINETS**

- A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch-thick galvanized sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
  2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick galvanized sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
  3. Recessed Flanges: Steel, finished to match cabinet.
  4. Control Access Door: Key operated.

5. Base: Minimum 0.0528-inch-thick steel, finished to match cabinet, 4 inches high with leveling bolts.
6. Extended Piping Compartment: 8-inch-wide piping end pocket.
7. False Back: Minimum 0.0428-inch-thick steel, finished to match cabinet.

#### **2.04 FILTERS**

- A. Minimum Arrestance: And a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  1. Washable Foam: 70 percent arrestance and MERV 3.
  2. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 5.
  3. Pleated: 90 percent arrestance and MERV 7.

#### **2.05 COILS**

- A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

#### **2.06 CONTROLS**

- A. Fan and Motor Board: Removable.
  1. Fan: Forward curved, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
  2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
  3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- B. Basic Unit Controls:
  1. Control voltage transformer.
  2. Unit-mounted thermostat with the following features:
    - a. Heat-off switch.
    - b. Fan on-auto switch.
    - c. Manual fan-speed switch.
    - d. Adjustable deadband.
    - e. Concealed set point.
    - f. Concealed indication.
    - g. Deg Findication.
  3. Unit-mounted temperature sensor.
  4. Unoccupied period override push button.
  5. Data entry and access port.
    - a. Input data includes room temperature and occupied and unoccupied periods.
    - b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

## **2.07 CAPACITIES AND CHARACTERISTICS**

- A. Refer to equipment schedule.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and 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 boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 07 92 00 "Joint Sealants."
- B. Install cabinet unit heaters to comply with NFPA 90A.
- C. Suspend cabinet unit heaters from structure with elastomeric hangers.
- D. 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.
- E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

### **3.03 CONNECTIONS**

- A. Piping installation requirements are specified in Section 23 21 13, Section 23 05 04, and Section 23 05 05. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Section 23 33 00 "Air Duct Accessories."
- E. Comply with safety requirements in UL 1995.
- F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater.
- G. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

### **3.04 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
  - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.



- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

**3.05 ADJUSTING**

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

**3.06 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

**END OF SECTION**



## **SECTION 23 82 39.16 PROPELLER UNIT HEATERS**

### **PART 1 GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. Section includes propeller unit heaters with hot-water coils.

#### **1.03 DEFINITIONS**

- A. CWP: Cold working pressure.
- B. PTFE: Polytetrafluoroethylene plastic.
- C. TFE: Tetrafluoroethylene plastic.

#### **1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include location and size of each field connection.
  - 4. Include details of anchorages and attachments to structure and to supported equipment.
  - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
  - 6. Indicate location and arrangement of piping valves and specialties.
  - 7. Indicate location and arrangement of integral controls.
  - 8. Wiring Diagrams: Power, signal, and control wiring.

#### **1.05 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Structural members to which propeller unit heaters will be attached.
  - 3. Method of attaching hangers to building structure.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Items penetrating finished ceiling, including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.

- d. Sprinklers.
  - e. Access panels.
- B. Field quality-control reports.

### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

## **PART 2 PRODUCTS**

### **2.01 DESCRIPTION**

- A. Assembly including casing, coil, fan, and motor in vertical and horizontal discharge configuration with adjustable discharge louvers. Refer to equipment schedule for orientation.
- 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.
- C. Comply with UL 2021.
- D. Comply with UL 823.

### **2.02 PERFORMANCE REQUIREMENTS**

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

### **2.03 HOUSINGS**

- A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

### **2.04 COILS**

- A. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.
- B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

### **2.05 FAN AND MOTOR**

- A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- B. Motor: Permanently lubricated. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

### **2.06 CONTROLS**

- A. Control Devices:
- 1. Unit mounted, fan-speed switch.
  - 2. Unit mounted thermostat.

## **2.07 CAPACITIES AND CHARACTERISTICS**

- A. Refer to equipment schedule.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and 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 propeller unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.
- C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers.
- D. 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.

### **3.03 CONNECTIONS**

- A. Drawings indicate general arrangement of piping, fittings, and specialties. Piping installation requirements are specified in the following Sections:
  - 1. Section 23 21 13
  - 2. Section 23 05 05
  - 3. Section 23 05 04
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Comply with safety requirements in UL 1995.
- E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties."
- F. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

### **3.04 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
  - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

**3.05 ADJUSTING**

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

**3.06 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

**END OF SECTION**

**SECTION 26 05 00**  
**COMMON WORK RESULTS FOR ELECTRICAL**

**PART 1 GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General Conditions, Supplemental General Conditions, and Division 1 Specification Sections apply to all Sections of Division 26.
- B. The requirements listed under General Conditions and Supplementary Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 26 and form a part of the contract.
- C. Division 1, Coordination, for additional requirements.
- D. Division 1, Cutting and Patching, for additional requirements.
- E. Division 1, Submittals, for additional requirements.
- F. Division 5, Metal Fabrication, for additional requirements.
- G. Division 7, Firestopping, for additional requirements.
- H. Division 7, Joint Sealants, for additional requirements.
- I. Division 9, Painting, for additional requirements.
- J. Division 31, Site Work for Trenching, Backfilling and Compaction requirements.

**1.02 SUMMARY**

- A. This Section includes general administrative and procedural requirements of electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
  - 1. Submittals
  - 2. Coordination Drawings
  - 3. Record Documents
  - 4. Maintenance Manuals
  - 5. Rough-Ins
  - 6. Electrical Installations
  - 7. Cutting and Patching

**1.03 ELECTRICAL DIVISION INDEX**

Section 26 0500	Common Work Results for Electrical
Section 26 0501	Basic Electrical Materials & Methods
Section 26 0502	Electrical Demolition
Section 26 0519	Low Voltage Electrical Power Conductors and
Cables	
Section 26 0523	Control-Voltage Electrical Power Cables
Section 26 0526	Grounding and Bonding for Electrical Systems
Section 26 0529	Hangers and Supports for Electrical Systems
Section 26 0533	Raceway and Boxes for Electrical Systems
Section 26 0553	Identification for Electrical Systems
Section 26 0573	Electrical System Studies
Section 26 2213	Low Voltage Distribution Transformers
Section 26 2413	Switchboards
Section 26 2416	Panelboards

Section 26 2726	Wiring Devices
Section 26 2813	Fuses
Section 26 2816	Enclosed Switches and Circuit Breakers
Section 26 2913	Enclosed Controllers
Section 26 4313	Transient Voltage Suppression for Low Voltage Electrical Power Circuits
Section 26 5113	Interior Lighting Fixtures, Lamps and Ballasts

#### 1.04 CODES AND PERMITS

- A. Perform electrical work in strict accordance with the applicable provisions of the National Electrical Code, Latest Edition; National Electric Safety Code, Latest Edition; [the International Building Code, 2015 Edition as adopted and interpreted by the State of Colorado, City of Colorado Springs, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.
- B. Secure and pay for all permits necessary for performance of the work. Pay for all utility connections unless otherwise specified herein.
- C. The following lists applicable codes and standards that, as a minimum, shall be followed.
  - Applicable county and state electrical codes, laws and ordinances.
  - National Electrical Manufacturer's Association Standards
  - National Electrical Code
  - National Electrical Safety Code
  - Underwriters Laboratories, Inc. Standards
  - American National Standards Institute
  - American Society for Testing Materials Standards
  - Standards and requirements of local utility companies
  - National Fire Protection Association Standards
  - Institute of Electrical and Electronics Engineers Standards
  - Insulated Cable Engineers Association
  - Occupational Safety and Health Act
  - Uniform Fire Code
  - Americans with Disabilities Act
  - Commercial and Industrial Insulation Standards (MICA)

#### 1.05 RECORD DRAWINGS

- A. Maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all electrical work, and in particular, where changes were made during construction. Use red color to indicate additions or corrections to prints, green color to indicate deletions, and yellow color to indicate items were installed as shown. Keep record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Architect during the construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached to record drawing set. Transmit drawings to the Architect at the conclusion of the project for delivery to the Owner's Representative.



## **1.06 QUALIFICATIONS**

- A. All electricians shall be skilled in their respective trade.

## **1.07 SUBSTITUTIONS**

- A. Identification of Division 26 equipment, fixtures, and materials listed within this Specification and in the Equipment Schedules on the drawings, which are identified by manufacturer's name, trade name, and/or model numbers are generally not meant to give preference to any manufacturer, but are provided to establish the design requirements and standards.
- B. Equipment submitted for substitution must fit the space conditions leaving adequate room for maintenance around all equipment. A minimum of 36 inches, or more if required by Code, must be maintained clear in front of all electrical panels, starters, gutters, or other electrical apparatus. Submit drawings showing the layout, size and exact method of interconnection of conduit, wiring and controls, which shall conform to the manufacturer's recommendations and these specifications. The scale of these drawings shall be scale of Contract Drawings. The Contractor shall bear the excess costs, by any and all crafts, of fitting the equipment into the space and the system designated. Where additional labor or material is required to permit equipment submitted for substitution to function in an approved manner, this shall be furnished and installed by the Contractor without additional cost to the Owner.
- C. Equipment submitted for substitution shall be approved in writing by the Owner or his representative and shall be accompanied by the following:
  - 1. A sample of each item submitted for substitution shall accompany the submittal.
  - 2. Provide a unit price quotation with each item intended for substitution. Include a unit price for the specified item and a unit price for the intended substitute item. Provide a total (per item) of the differential payback to the Owner should the intended substitute item be approved as equivalent to that which is specified.
  - 3. Reimburse the Owner for the Architect/Engineer's additional services required to review and process substitutions.

## **1.08 PRIOR APPROVAL**

- A. Requests for proposed substitutions shall be accompanied with catalog and technical data. Actual equipment components and options shall be highlighted and any discrepancies with the specified equipment noted.
- B. One (1) copy of prior approval submittal data shall be sent to the Architect with the second copy sent directly to the engineer.
- C. Requests for prior approval received after the specified due date will not be considered.
- D. Division 26 prior approval equipment, fixtures, and materials which are submitted as specified herein and accepted will be included in an Addendum. Equipment, fixtures and materials which are accepted under this prior approval process are accepted for bidding purposes only, subject to all requirements, terms, and conditions of the Contract Documents.
- E. Submit prior approval substitution requests utilizing the Substitution Request Form included at the end of this section.

## **1.09 HAZARDOUS CONDITIONS**

- A. Protruding metal (bolts, steel angles, etc.) potentially hazardous to maintenance and operation personnel, shall be cut back and/or protected to reduce the risk of injury.

## **1.10 DEFINITIONS**

- A. Definitions of terms will be found in the National Electrical Code.

- B. Whenever a term is used in this Specification which is defined in the Code, the definition given will govern its meaning in this Specification.
- C. Whenever a technical term is used which does not appear in the Code, the definition to govern its meaning in these Specifications will be found in the Standard Dictionary of Electrical and Electronic Terms, published by the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08855-1331.
- D. "Provide" means furnish, install, connect and test unless otherwise noted.

#### **1.11 SUBMITTALS**

- A. The Contractor shall submit submittal brochures of equipment, fixtures and materials to be furnished under Division 26.
- B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.
- C. Install equipment in accordance with the manufacturer's recommendations. Provide accessories and components for optimum operation as recommended by the manufacturer.
- D. Costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.
- E. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification from the Architect/Engineer that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED." Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter to the Architect/Engineer.
- F. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including a minimum of 3 feet clear in front of all electrical equipment and panels as defined by the National Electrical Code. Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.
- G. Shop Drawings: Unless the following information is included, shop drawings will be returned unchecked:
  - 1. Cover sheet for each submittal, listing equipment, products, and materials, and referencing data and sections in Specifications and drawings. Clearly reference project name and provide space for a review stamp.

2. Cover sheet shall clearly identify deviations from specifications, and justification.

3. Include all related equipment in a single submittal to allow complete review. Similar equipment may be submitted under a common cover sheet.
  4. Size, dimensions, and weight of equipment.
  5. Equipment performance under specified conditions, not a copy of scheduled data on drawings.
  6. Indicate actual equipment proposed, where data sheets indicate more than one (1) device or equipment.
- H. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.
- I. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted, for review by the Architect with the shop drawing submittals of the substituted. Failure to comply with this requirement will result in the shop drawings being returned unchecked.
- J. Submittals and one (1) resubmittal will be reviewed by the Architect/Engineer. If the Contractor fails to provide the required data with his second submittal, he will be charged for the third and subsequent reviews.
- K. See Division 1 for additional submission requirements.

#### **1.12 MAINTENANCE MANUALS**

- A. Prepare maintenance manuals in accordance with Division 1, Section 017823 - PROJECT CLOSEOUT. In addition to the requirements specified in Division 1, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
  2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  4. Servicing instructions and lubrication charts and schedules.

#### **1.13 USE OF CADD FILES**

- A. Under certain conditions, the Contractor will be permitted the use of the Engineer's CADD files for documentation of as-builts, submittals, or coordination drawings.
- B. The Engineer shall be compensated for the time required to format the CADD files for delivery to the Contractor. Such work may include removal of title blocks, professional seals, calculations, proprietary information, etc.
- C. The Contractor shall complete the enclosed License, Indemnity and Warranty Agreement, complete with contractor's name, address, and Contractor's

Representative signature prior to request for CADD file usage.

#### **1.14 DRAWINGS AND SPECIFICATIONS**

- A. Electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of the other sections shall permit. Size and location of equipment is drawn to scale wherever possible. Do not scale from electrical drawings.
- B. Drawings and specifications are for the assistance and guidance of the Contractor. Exact locations, distances, and levels will be governed by the building. The Contractor shall make use of data in all the Contract Documents to verify information at the building site.
- C. In any case where there appears to be a conflict between that which is shown on the electrical drawings, and that shown in any other part of the Contract Documents, the Contractor shall notify and secure directions from the Architect.
- D. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification. Do not proceed with work without direction.
- E. They shall interpret the drawings and the specifications. The interpretation as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished there under shall be accepted as final and conclusive.
- F. In the case of conflicts not clarified prior to the bidding deadline, use the most costly alternative (better quality, greater quantity, and larger size) in preparing the bid. A clarification will be issued to the successful bidder as soon as feasible after the award and, if appropriate, a deductive change order will be issued.
- G. Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras indicated on the drawings or in the specifications.
- H. Investigate structural and finish conditions and arrange work accordingly. Provide all fittings, equipment, and accessories required for actual conditions.

#### **1.15 SIMILAR MATERIALS**

- A. All items of a similar type shall be products of the same manufacturer.
- B. Contractor shall coordinate among suppliers of various equipment to assure that similar equipment type is product of the same manufacturer.
- C. Examples of similar equipment types include but are not limited to:
  - 1. Power Circuit Breakers
  - 2. Enclosed Case Circuit Breakers
  - 3. Batteries
  - 4. UPS
  - 5. TVSS
  - 6. Engine-Generators
  - 7. Motor Starters
  - 8. Transformers
  - 9. Panelboards
  - 10. Disconnects
  - 11. Fuses

12. Transfer Switch
13. Computer Power Distribution Units



## **1.16 DELIVERY, STORAGE AND HANDLING**

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

## **1.17 GUARANTEE-WARRANTY**

- A. See Division 1 for warranties.
- B. The following guarantee is a part of the specifications and shall be binding on the Contractor:

"The Contractor guarantees that this installation is free from ALL defects. He agrees to replace or repair any part of the installation which may fail within a period of one (1) year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor-furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date to be determined in writing by means of issuing a 'Certificate of Substantial Completion', AIA Form G704."
- C. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee-warranty to the Owner.

## **PART 2 PRODUCTS**

### **2.01 QUALITY OF MATERIALS**

- A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of electrical equipment, and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.
- B. Hazardous or Environmentally Damaging Materials: Products shall not contain asbestos, mercury, PCBs, or other materials harmful to people or the environment.

### **2.02 ALTITUDE RATINGS**

- A. Unless otherwise noted, all specified equipment capacities are for an altitude of 6180 feet above sea level and adjustments to manufacturer's ratings must be made accordingly.

### **2.03 EQUIPMENT REQUIREMENTS**

- A. The electrical requirements for equipment specified or indicated on the drawings are based on information available at the time of design. If equipment furnished for installation has electrical requirements other than those indicated on the electrical drawings, make all adjustments to wire and conduit size, controls, over current protection and installation as required to accommodate the equipment supplied. Delineate all adjustments to the drawings reflecting the electrical system in a submittal to the Contract Administrator immediately upon knowledge of the required adjustment.

## **PART 3 EXECUTION**

### **3.01 COOPERATION WITH OTHER TRADES**

- A. Coordinate all work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

### **3.02 DRAWINGS**

- A. The electrical drawings show the general arrangement of all lighting, power, special systems, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents shall be considered as part of the work. Coordinate with architectural, mechanical, and structural drawings. Because of the small scale of the electrical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Provide all fittings, boxes, and accessories as may be required to meet actual conditions. Should conditions necessitate a rearrangement of equipment, such departures and the reasons therefore, shall be submitted by the Contractor for review in the form of detailed drawings showing the proposed changes. No changes shall be made without the prior written approval. All changes shall be marked on record drawings.
- B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted in writing.
- C. Installation of all equipment shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearance, as defined by the National Electrical Code (NEC).
- D. The installation of all concealed electrical systems shall be carefully arranged to fit within the available space without interference with adjacent structural and mechanical systems.

### **3.03 ELECTRICAL INSTALLATIONS**

- A. General: Sequence, coordinate, and integrate the various elements of electrical system, materials, and equipment. Comply with the following requirements:
  - 1. Coordinate electrical systems, equipment, and materials installation with all other building components.
  - 2. Verify all dimensions by field measurements.
  - 3. Arrange for chases, slots, and openings in all other building components during progress of construction, to allow for electrical installations.
  - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
  - 5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
  - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum clearance possible.
  - 7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
  - 8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

9. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
10. Install access panel or doors where units are concealed behind finished surfaces.
11. Install systems, materials, and equipment giving right-of-way priority to systems requiring installation at a specified slope.

#### **3.04 FIELD MEASUREMENTS**

- A. No extra compensation shall be claimed or allowed due to differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, and shall report any work which must be corrected. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the electrical work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor.

#### **3.05 EQUIPMENT SUPPORT**

- A. Provide support for equipment to the building structure. Provide all necessary structures, inserts, sleeves, firestops and hanging devices for installation of equipment. Coordinate installation of devices. Verify with the Architect that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

#### **3.06 PAINTING**

- A. All finish painting of electrical systems and equipment will be under "Painting," unless equipment is hereinafter specified to be painted.
- B. All equipment shall be provided with factory applied standard finish, unless otherwise specified.
- C. Touch-Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished to the satisfaction of the Architect.

#### **3.07 SEISMIC SUPPORTS**

- A. The Contractor shall be responsible for all anchors and connections for the electrical work to the building structure to prevent damage of equipment and systems due to seismic activity.

#### **3.08 PROTECTION OF MATERIALS AND EQUIPMENT**

- A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.
- B. All items of electrical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner approved by the Architect.
- C. The Contractor shall provide protection for all work and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Architect prior to such storage.
- D. Conduit openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fixtures,

equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect.

### **3.09 EXCAVATION**

- A. Provide all excavation, trenching and backfilling required.
- B. Slope sides of excavations to comply with codes and ordinances. Shore and brace as required for stability of excavation.

### **3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGE**

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

### **3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGE**

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### **3.12 APPLICATION OF JOINT SEALERS**

- A. General: Comply with joint sealer manufacturer's printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
  - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
  - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
- C. Firestopping Sealant: Provide sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

### **3.13 INSTALLATION OF ACCESS DOORS**

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

### **3.14 CUTTING AND PATCHING**

- A. Perform cutting and patching in accordance with Division 1, Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
  - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
    - a. Remove and replace defective Work.

- b. Remove and replace Work not conforming to requirements of the Contract Documents.
  - c. Remove samples of installed Work as specified for testing.
  - d. Install equipment and materials in existing structures.
  - e. Upon written instructions from the Contracting Officer, uncover and restore Work to provide for Contracting Officer observation of concealed Work.
2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
  3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
  4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
  5. During cutting and patching operations, protect adjacent installations.
  6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers.

### **3.15 MANUFACTURER'S INSTRUCTIONS**

- A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall submit such conflicts to the Architect who shall make such compromises as he deems necessary and desirable.

### **3.16 CONCRETE BASES AND HOUSEKEEPING PADS**

- A. Install concrete bases and housekeeping pads under all freestanding electrical equipment unless otherwise noted.
- B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all anchor bolts, etc. Coordinate weight of concrete bases and housekeeping pads with the structural engineer.
- C. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with Carborundum block after stripping forms. Tops shall be level. Provide dowel rods or other required material in floor for lateral stability and anchorage.

### **3.17 TESTS**

- A. All tests shall be conducted in the presence of the designated and authorized Owner's Representative. The Contractor shall notify the Architect one week in advance of all tests. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

### **3.18 OPERATION AND MAINTENANCE INSTRUCTIONS**

- A. The Contractor shall furnish the complete operating and maintenance instructions covering all units of electrical equipment herein specified together with parts lists. Furnish two (2) copies of all the literature; each shall be suitably bound in loose leaf book form.
- B. Operating and maintenance manuals as required herein shall be submitted for review not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

- C. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the electrical systems and equipment for a period of five (5) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

### **3.19 CERTIFICATIONS**

- A. Before receiving final payment, certify in writing that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these specifications. Submit certifications and acceptance certificates to the Architect including proof of delivery of O&M manuals, spare parts required, and equipment warranties which shall be bound with O&M manuals.

### **3.20 INTERRUPTING SERVICES**

- A. The Contractor shall coordinate the installation of all work within the building in order to minimize interference with the operation of existing building electrical telephone, fire alarm, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written review.

### **3.21 SITE VISITS AND OBSERVATION OF CONSTRUCTION**

- A. The Architect/Engineer will make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation by the Architect/Engineer however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities, nor shall the Architect/Engineer have authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

**END OF SECTION**

**DIVISION 26 SUBSTITUTION REQUEST FORM (SRF)**

TO: BRIDGERS & PAXTON CONSULTING ENGINEERS, INC.

PROJECT: \_\_\_\_\_

We hereby submit for your consideration the following product instead of the specified item for the above project:

Section: \_\_\_\_\_ Page: \_\_\_\_\_ Paragraph/Line: \_\_\_\_\_ Specified Item: \_\_\_\_\_

Proposed Substitution: \_\_\_\_\_

Attach complete product description, drawings, photographs, performance and test data, and other information necessary for evaluation. Identify specific Model Numbers, finishes, options, etc.

1. Will changes be required to building design in order to properly install proposed substitutions?  
YES  NO   
If YES, explain: \_\_\_\_\_

2. Will the undersigned pay for changes to the building design, including engineering and drawing costs, caused by requested substitutions? YES  NO

3. List differences between proposed substitutions and specified item.

Specified Item	Proposed Substitution
_____	_____

4. Does substitution affect Drawing dimensions? YES  NO

5. What affect does substitution have on other trades? \_\_\_\_\_

6. Does the manufacturer's warranty for proposed substitution differ from that specified?  
YES  NO   
If YES, explain: \_\_\_\_\_

7. Will substitution affect progress schedule? YES  NO   
If YES, explain: \_\_\_\_\_

8. Will maintenance and service parts be locally available for substitution? YES  NO   
If YES, explain: \_\_\_\_\_

9. Is substitution identical in appearance and function to specialized product? YES  NO



Submitting Firm: \_\_\_\_\_ Date: \_\_\_\_\_  
Address: \_\_\_\_\_  
Signature: \_\_\_\_\_ Telephone: \_\_\_\_\_

**For Engineer's Use Only**  
Accepted: \_\_\_\_\_ Not Accepted: \_\_\_\_\_ Received Too Late: \_\_\_\_\_  
By: \_\_\_\_\_ Date: \_\_\_\_\_  
Remarks: \_\_\_\_\_  
\_\_\_\_\_

**LICENSE AGREEMENT FOR CADD DATABASE OR BIM MODEL**

**PROJECT:** \_\_\_\_\_

**LICENSE GRANT:** Contractor is granted use of the CADD Database or BIM Model (Database/Model) for the indicated project for the specific purpose of preparing submittal documents for this Project. No other use of the Database/Model is granted. Title to the Database/Model is not transferred to the Contractor. The Database/Model may be of value to the Contractor in preparing submittals, but use of the model does not relieve the contractor of the requirement to verify measurements in the field.

**COPYING RESTRICTIONS:** Contractor may copy the Database/Model in whole or in part, but only for backup and archival purposes or for use by the Contractor's Subcontractors. Contractor agrees to ensure that any entities that receive the Database/Model from Contractor, either in whole or in part, comply with the terms and conditions of this agreement. Contractor shall safeguard the Database/Model from falling into the hands of parties other than Subcontractors with a legitimate need for it.

**WARRANTY:** Bridgers & Paxton (B&P) offers this Database/Model without warranty and specifically without express or implied warranty of fitness. If Contractor chooses to use the Database/Model, then he does so at his own risk and without any liability or risk to B&P.

**INDEMNITY:** Contractor shall to the fullest extent permitted by law, defend, indemnify and hold harmless the Owner, Architect, B&P, their employees and agents from all claims, damages, losses, and attorney fees arising out of or resulting from the use of the Database/Model.

**ACKNOWLEDGMENT:** Contractor acknowledges that (s)he has read this Agreement, understands it, and agrees to be bound by its terms and conditions.

**CONTRACTOR'S REPRESENTATIVE**

Signature: \_\_\_\_\_ Company Name: \_\_\_\_\_

Name: \_\_\_\_\_ Address 1: \_\_\_\_\_

Title: \_\_\_\_\_ Address 2: \_\_\_\_\_

Date: \_\_\_\_\_

## SECTION 26 05 19

### LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section Includes:
  - 1. Copper building wire rated 600 V or less.
  - 2. Aluminum building wire rated 600 V or less.
  - 3. Metal-clad cable, Type MC, rated 600 V or less.
  - 4. Armored cable, Type AC, rated 600 V or less.
  - 5. Connectors, splices, and terminations rated 600 V and less.
- B. Related Requirements:
  - 1. Section 26 05 23 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

##### 1.03 DEFINITIONS

- A. PV: Photovoltaic.
- B. RoHS: Restriction of Hazardous Substances.
- C. VFC: Variable-frequency controller.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer's authorized service representative.
- B. Field quality-control reports.

##### 1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

#### PART 2 PRODUCTS

##### 2.01 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. RoHS compliant.
  - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

- D. Conductor Insulation:
  - 1. Type RHH and Type RHW-2: Comply with UL 44.
  - 2. Type THHN and Type THWN-2: Comply with UL 83.
  - 3. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
  - 4. Type UF: Comply with UL 83 and UL 493.
  - 5. Type XHHW-2: Comply with UL 44.
- E. Shield:
  - 1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

## **2.02 ALUMINUM BUILDING WIRE**

- A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. RoHS compliant.
  - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Aluminum, complying with ASTM B 800 and ASTM B 801.
- D. Conductor Insulation:
  - 1. Type RHH and Type RHW-2: Comply with UL 44.
  - 2. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
  - 3. Type THHN and Type THWN-2: Comply with UL 83.
  - 4. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
  - 5. Type XHHW-2: Comply with UL 44.

## **2.03 METAL-CLAD CABLE, TYPE MC**

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. Comply with UL 1569.
  - 3. RoHS compliant.
  - 4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Circuits:
  - 1. Retain first option in first subparagraph below for single-circuit Type MC cable. Retain second option to allow multiple circuits per cable. If retaining both options, indicate where used on Drawings.
  - 2. Single circuit and multicircuit with color-coded conductors.
  - 3. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Ground Conductor: Insulated.
- F. Conductor Insulation:
  - 1. Type TFN/THHN/THWN-2: Comply with UL 83.
  - 2. Type XHHW-2: Comply with UL 44.
- G. Armor: Steel, interlocked.
- H. Jacket: PVC applied over armor.

#### **2.04 ARMORED CABLE, TYPE AC**

- A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.
- B. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. RoHS compliant.
  - 3. Comply with UL 4.
  - 4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Circuits:
  - 1. Single circuit and multicircuit with color-coded conductors.
  - 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Ground Conductor: Insulated.
- F. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.
- G. Armor: Steel, interlocked.

#### **2.05 CONNECTORS AND SPLICES**

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
  - 1. Material: Copper.
  - 2. Type: One hole with standard barrels.
  - 3. Termination: Compression.

### **PART 3 EXECUTION**

#### **3.01 CONDUCTOR MATERIAL APPLICATIONS**

- A. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

- B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.
- D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

### **3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS**

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway, Armored cable, Type AC, Metal-clad cable, Type MC.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- I. VFC Output Circuits: Type XHHW-2 in metal conduit, Type TC-ER cable with braided shield.

### **3.03 INSTALLATION OF CONDUCTORS AND CABLES**

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

### **3.04 CONNECTIONS**

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
  - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

### **3.05 IDENTIFICATION**

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

### **3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### **3.07 FIRESTOPPING**

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

### **3.08 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
  - 2. Perform each of the following visual and electrical tests:
    - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    - b. Test bolted connections for high resistance using one of the following:
      - 1) A low-resistance ohmmeter.
      - 2) Calibrated torque wrench.
      - 3) Thermographic survey.
    - c. Inspect compression-applied connectors for correct cable match and indentation.
    - d. Inspect for correct identification.
    - e. Inspect cable jacket and condition.

- f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    - g. Continuity test on each conductor and cable.
    - h. Uniform resistance of parallel conductors.
  - 3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
    - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
  - 4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- E. Cables will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports to record the following:
  - 1. Procedures used.
  - 2. Results that comply with requirements.
  - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

**END OF SECTION**



**SECTION 26 05 23**  
**CONTROL-VOLTAGE ELECTRICAL POWER CABLES**

**PART 1 GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section Includes:
  - 1. Backboards.
  - 2. RS-485 cabling.
  - 3. Low-voltage control cabling.
  - 4. Control-circuit conductors.
  - 5. Identification products.

**1.03 DEFINITIONS**

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. RCDD: Registered Communications Distribution Designer.

**1.04 ACTION SUBMITTALS**

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

**1.05 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

**1.06 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

**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. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
  - 1. Flame Travel Distance: 60 inches (1520 mm) or less.

2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- E. RoHS compliant.

## **2.02 BACKBOARDS**

- A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."
- B. Painting: Paint plywood on all sides and edges with flat paint. Comply with requirements in Section 099123 "Interior Painting."

## **2.03 RS-485 CABLE**

- A. Standard Cable: NFPA 70, Type CMG.
  1. Paired, one pair, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
  2. PVC insulation.
  3. Unshielded.
  4. PVC jacket.
  5. Flame Resistance: Comply with UL 1685.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
  1. Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.
  2. Fluorinated ethylene propylene insulation.
  3. Unshielded.
  4. Fluorinated ethylene propylene jacket.
  5. Flame Resistance: NFPA 262.

## **2.04 LOW-VOLTAGE CONTROL CABLE**

- A. Paired Cable: NFPA 70, Type CMG.
  1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  2. PVC insulation.
  3. Unshielded.
  4. PVC jacket.
  5. Flame Resistance: Comply with UL 1685.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
  1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  2. PVC insulation.
  3. Unshielded.
  4. PVC jacket.
  5. Flame Resistance: Comply with NFPA 262.

## **2.05 CONTROL-CIRCUIT CONDUCTORS**

- A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
  - 1. Smoke control signaling and control circuits.

## **2.06 SOURCE QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Test cables on receipt at Project site.
  - 1. Test each pair of twisted pair cable for open and short circuits.

### **3.02 INSTALLATION OF RACEWAYS AND BOXES**

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
  - 1. Outlet boxes for cables shall be no smaller than 4 inches (102 mm) square by 2-1/8 inches (53 mm) deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
  - 2. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
  - 1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
  - 2. Install cable trays to route cables if conduits cannot be located in these positions.
  - 3. Secure conduits to backboard if entering the room from overhead.
  - 4. Extend conduits 3 inches (75 mm) above finished floor.
  - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

### 3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with TIA-568-C Series of standards.
  - 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
  - 5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
  - 6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
  - 8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
  - 9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
  - 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
  - 11. Support: Do not allow cables to lie on removable ceiling tiles.
  - 12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
  - 13. Provide strain relief.
  - 14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
  - 15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
- C. Installation of Control-Circuit Conductors:
  - 1. Install wiring in raceways.
  - 2. Use insulated spade lugs for wire and cable connection to screw terminals.
  - 3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Open-Cable Installation:
  - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

### **3.04 REMOVAL OF CONDUCTORS AND CABLES**

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

### **3.05 CONTROL-CIRCUIT CONDUCTORS**

- A. Minimum Conductor Sizes:
  1. Class 1 remote-control and signal circuits; No 14 AWG.
  2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
  3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

### **3.06 FIRESTOPPING**

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

### **3.07 GROUNDING**

- A. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

### **3.08 IDENTIFICATION**

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.
- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

### **3.09 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
  1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
  - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- F. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- H. Prepare test and inspection reports.

**END OF SECTION**

## SECTION 26 05 26

### GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

##### 1.03 ACTION SUBMITTALS

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

##### 1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

##### 1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
    - 1) Ground rods.
    - 2) Ground rings.
    - 3) Grounding arrangements and connections for separately derived systems.
  - b. Instructions for periodic testing and inspection of grounding features at ground rings, grounding connections for separately derived systems based on NETA MTS.

- 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
- 2) Include recommended testing intervals.

## **1.06 QUALITY ASSURANCE**

A. Testing Agency Qualifications: Certified by NETA.

## **PART 2 PRODUCTS**

### **2.01 SYSTEM DESCRIPTION**

- 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. Comply with UL 467 for grounding and bonding materials and equipment.

### **2.02 MANUFACTURERS**

A. List of Manufacturers

### **2.03 CONDUCTORS**

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  1. Solid Conductors: ASTM B 3.
  2. Stranded Conductors: ASTM B 8.
  3. Tinned Conductors: ASTM B 33.
  4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
  5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
  7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

### **2.04 CONNECTORS**

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.



- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- K. Lay-in Lug Connector: Mechanical type, aluminum terminal with set screw.
- L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- N. Straps: Solid copper, cast-bronze clamp. Rated for 600 A.
- O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal [one] [two]-piece clamp.
- P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- Q. Water Pipe Clamps:
  - 1. Mechanical type, two pieces with zinc-plated bolts.
    - a. Material: Tin-plated aluminum.
    - b. Listed for direct burial.
  - 2. U-bolt type with malleable-iron clamp and copper ground connector.

## **2.05 GROUNDING ELECTRODES**

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m).
- B. Ground Plates: 1/4 inch (6 mm) thick, hot-dip galvanized.

## **PART 3 EXECUTION**

### **3.01 APPLICATIONS**

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
  - 1. Bury at least 24 inches (600 mm) below grade.
  - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
  - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

**3.02 GROUNDING AT THE SERVICE**

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

**3.03 GROUNDING SEPARATELY DERIVED SYSTEMS**

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

**3.04 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS**

- A. Comply with IEEE C2 grounding requirements.

**3.05 EQUIPMENT GROUNDING**

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
  2. Lighting circuits.
  3. Receptacle circuits.
  4. Single-phase motor and appliance branch circuits.
  5. Three-phase motor and appliance branch circuits.
  6. Flexible raceway runs.
  7. Armored and metal-clad cable runs.
  8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- H. Metallic Fences: Comply with requirements of IEEE C2.
  - 1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
  - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
  - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

### **3.06 FENCE GROUNDING**

- A. Fence Grounding: Install at maximum intervals of 1500 feet (450 m) except as follows:
  - 1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m).
    - a. Gates and Other Fence Openings: Ground fence on each side of opening.
      - 1) Bond metal gates to gate posts.
      - 2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.
- C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
- D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
- E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- F. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

### **3.07 INSTALLATION**

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest

point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  - 2. Use exothermic welds for all below-grade connections.
  - 3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
  - 1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
  - 2. Bury ground ring not less than 24 inches (600 mm) from building's foundation.

- I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
  - 1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
  - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- J. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure 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. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

### **3.08 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without 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.
    - b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- F. Grounding system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
  3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
- I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

**END OF SECTION**

**SECTION 26 05 29**  
**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

**1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

A. Section Includes:

1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

**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. Slotted support systems, hardware, and accessories.
  - b. Clamps.
  - c. Hangers.
  - d. Sockets.
  - e. Eye nuts.
  - f. Fasteners.
  - g. Anchors.
  - h. Saddles.
  - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.

4. 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 hangers and supports for electrical systems.
1. Include design calculations and details of hangers.
  2. Include design calculations for seismic restraints.

#### **1.04 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components.
  2. Ductwork, piping, fittings, and supports.
  3. Structural members to which hangers and supports will be attached.
  4. Size and location of initial access modules for acoustical tile.
  5. Items penetrating finished ceiling, including the following:
    - a. Luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Projectors.
- B. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Welding certificates.

#### **1.05 QUALITY ASSURANCE**

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M.
  2. AWS D1.2/D1.2M.

### **PART 2 PRODUCTS**

#### **2.01 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.



1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."
  2. Component Importance Factor: 1.5.
- C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Rating: Class 1.
  2. Self-extinguishing according to ASTM D 635.

## **2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  2. Material for Channel, Fittings, and Accessories: Galvanized steel.
  3. Channel Width: Selected for applicable load criteria.
  4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  2. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless] steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

### **2.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES**

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

## **PART 3 EXECUTION**

### **3.01 APPLICATION**

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  1. NECA 1.
  2. NECA 101
  3. NECA 102.
  4. NECA 105.
  5. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

### **3.02 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, according to NFPA 70.
- C. 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 (90 kg).

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
  2. To New Concrete: Bolt to concrete inserts.
  3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  4. To Existing Concrete: Expansion anchor fasteners.
  5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
  7. To Light Steel: Sheet metal screws.
  8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

### **3.03 INSTALLATION OF FABRICATED METAL SUPPORTS**

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### **3.04 CONCRETE BASES**

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
  1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### **3.05 PAINTING**

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION**

## **SECTION 26 05 33**

### **RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

##### **1.03 DEFINITIONS**

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

##### **1.04 ACTION SUBMITTALS**

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

##### **1.05 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
  2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.

- C. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- D. Source quality-control reports.

## **PART 2 PRODUCTS**

### **2.01 METAL CONDUITS AND FITTINGS**

#### A. Metal Conduit:

1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. GRC: Comply with ANSI C80.1 and UL 6.
3. ARC: Comply with ANSI C80.5 and UL 6A.
4. IMC: Comply with ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - a. Comply with NEMA RN 1.
  - b. Coating Thickness: 0.040 inch (1 mm), minimum.
6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

#### B. Metal Fittings:

1. Comply with NEMA FB 1 and UL 514B.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fittings, General: Listed and labeled for type of conduit, location, and use.
4. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
5. Fittings for EMT:
  - a. Material: **Steel**.
  - b. Type: [**Setscrew**] [or] [**compression**].
6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

- C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## **2.02 NONMETALLIC CONDUITS AND FITTINGS**

### **A. Nonmetallic Conduit:**

1. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Fiberglass:
  - a. Comply with NEMA TC 14.
  - b. Comply with UL 2515 for aboveground raceways.
  - c. Comply with UL 2420 for belowground raceways.
3. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
4. LFNC: Comply with UL 1660.
5. Rigid HDPE: Comply with UL 651A.
6. Continuous HDPE: Comply with UL 651A.
7. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
8. RTRC: Comply with UL 2515A and NEMA TC 14.

### **B. Nonmetallic Fittings:**

1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
  - a. Fittings for LFNC: Comply with UL 514B.
3. Solvents and Adhesives: As recommended by conduit manufacturer.

## **2.03 METAL WIREWAYS AND AUXILIARY GUTTERS**

### **A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.**

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### **B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.**

### **C. Wireway Covers: Hinged type unless otherwise indicated.**

### **D. Finish: Manufacturer's standard enamel finish.**

## **2.04 SURFACE RACEWAYS**

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

## **2.05 BOXES, ENCLOSURES, AND CABINETS**

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Metal Floor Boxes:
  - 1. Material: Cast metal.
  - 2. Type: Fully adjustable.
  - 3. Shape: Rectangular.
  - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
  - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- L. Gangable boxes are allowed.
- M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Nonmetallic Enclosures: Plastic.
  - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.



N. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**2.06 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING**

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

**2.07 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES**

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

## **PART 3 EXECUTION**

### **3.01 RACEWAY APPLICATION**

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
  2. Concealed Conduit, Aboveground: GRC.
  3. Underground Conduit: RNC, Type EPC-40-PVC.
  4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
  2. Exposed, Not Subject to Severe Physical Damage: EMT.
  3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
    - d. Gymnasiums.
  4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  6. Damp or Wet Locations: GRC.
  7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 1/2-inch (16-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
  4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

### **3.02 INSTALLATION**

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- L. Raceways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
  - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  - 3. Arrange raceways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
  - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- M. Stub-ups to Above Recessed Ceilings:
  - 1. Use EMT, IMC, or RMC for raceways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- T. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- V. Surface Raceways:
1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
  2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where an underground service raceway enters a building or structure.
  3. Conduit extending from interior to exterior of building.
  4. Conduit extending into pressurized duct and equipment.
  5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  6. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
  2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
    - d. Attics: 135 deg F (75 deg C) temperature change.
  3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches (915 mm) of flexible conduit for [recessed and semirecessed luminaires, ]equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
  2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

- EE. Locate boxes so that cover or plate will not span different building finishes.
- FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- HH. Set metal floor boxes level and flush with finished floor surface.
- II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### **3.03 INSTALLATION OF UNDERGROUND CONDUIT**

#### **A. Direct-Buried Conduit:**

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

### **3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES**

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### **3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### **3.06 FIRESTOPPING**

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### **3.07 PROTECTION**

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION**





## SECTION 26 05 44

### SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

##### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

#### PART 2 PRODUCTS

##### 2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
  - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

- b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

## **2.2 SLEEVE-SEAL SYSTEMS**

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  2. Pressure Plates: Carbon steel.
  3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

## **2.3 SLEEVE-SEAL FITTINGS**

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

## **2.4 GROUT**

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## **2.5 SILICONE SEALANTS**

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## **PART 3 EXECUTION**

### **3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS**

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

### **3.2 SLEEVE-SEAL-SYSTEM INSTALLATION**

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### **3.3 SLEEVE-SEAL-FITTING INSTALLATION**

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

## **END OF SECTION**



## **SECTION 26 05 53**

### **IDENTIFICATION FOR ELECTRICAL SYSTEMS**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

##### **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 electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For arc-flash hazard study.

#### **PART 2 PRODUCTS**

##### **2.01 PERFORMANCE REQUIREMENTS**

A. Comply with ASME A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## **2.02 COLOR AND LEGEND REQUIREMENTS**

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

B. Color-Coding for Phase-and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:
  - a. Phase A: Black.
  - b. Phase B: Red.
  - c. Phase C: Blue.
3. Colors for 480/277-V Circuits:
  - a. Phase A: Brown.
  - b. Phase B: Orange.
  - c. Phase C: Yellow.
4. Color for Neutral: **[White]** **[or]** **[gray]**.
5. Color for Equipment Grounds: Green.
6. Colors for Isolated Grounds: Green with white stripe.

C. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

F. Equipment Identification Labels:

1. Black letters on a white field.

## **2.03 LABELS**

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

- C. Self-Adhesive Wraparound Labels: Write-on, 3-mil- (0.08-mm-) thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
  - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
  - 2. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
  - 1. Minimum Nominal Size:
    - a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
    - b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
    - c. As required by authorities having jurisdiction.

#### **2.04 BANDS AND TUBES**

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F (93 deg C). Comply with UL 224.

#### **2.05 TAPES AND STENCILS**

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide; compounded for outdoor use.
- C. Tape and Stencil: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers placed diagonally over orange background and is 12 inches (300 mm) wide. Stop stripes at legends.
- D. Floor Marking Tape: 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with [black and white] [yellow and black] stripes and clear vinyl overlay.
- E. Underground-Line Warning Tape:
  - 1. Tape:
    - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
    - b. Printing on tape shall be permanent and shall not be damaged by burial operations.

- c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- 2. Color and Printing:
  - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
  - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE"
  - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
- 3. Tag: Type I:
  - a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
  - b. Width: 3 inches (75 mm).
  - c. Thickness: 4 mils (0.1 mm).
  - d. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).
  - e. Tensile according to ASTM D 882: 30 lbf (133.4 N) and 2500 psi (17.2 MPa).
- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

## **2.06 TAGS**

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, [0.015 inch (0.38 mm)] [0.023 inch (0.58 mm)] thick, color-coded for phase and voltage level, with factory [screened] [printed] permanent designations; punched for use with self-locking cable tie fastener.
- C. Write-on Tags:
  - 1. Polyester Tags: [0.010 inch (0.25 mm)] [0.015 inch (0.38 mm)] <Insert dimension> thick, with corrosion-resistant grommet and cable tie for attachment.
  - 2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## **2.07 SIGNS**

- A. Baked-Enamel Signs:
  - 1. Preprinted aluminum signs, [high-intensity reflective, ]punched or drilled for fasteners, with colors, legend, and size required for application.
  - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
  - 3. Nominal Size: 7 by 10 inches (180 by 250 mm).

## **2.08 CABLE TIES**

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch (5 mm).



2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
  3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
  4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
  2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
  3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
  4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch (5 mm).
  2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D 638: 7000 psi (48.2 MPa).
  3. UL 94 Flame Rating: 94V-0.
  4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
  5. Color: Black.

## **2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS**

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

### **3.02 INSTALLATION**

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
  2. "POWER."
  3. "UPS."
- M. Vinyl Wraparound Labels:
1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
  2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- W. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
  2. Limit use of underground-line warning tape to direct-buried cables.
  3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- X. Metal Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using plenum-rated cable ties.
- Y. Nonmetallic Preprinted Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using general-purpose, plenum-rated cable ties.
- Z. Write-on Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using general-purpose, plenum-rated cable ties.
- AA. Baked-Enamel Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on minimum 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use signs minimum 2 inches (50 mm) high.
- BB. Metal-Backed Butyrate Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use labels 2 inches (50 mm) high.
- CC. Laminated Acrylic or Melamine Plastic Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use labels 2 inches (50 mm) high.

DD. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

### 3.03 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch- (75-mm-) high, black letters on 20-inch (500-mm) centers.
  1. Locate identification at changes in direction, at penetrations of walls and floors, and at [10-foot (3-m)] [30-foot (10-m)] maximum intervals.
- D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Vinyl wraparound labels.
  1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels
  1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
  1. "EMERGENCY POWER."
  2. "POWER."
  3. "UPS."
- G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
  1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- H. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.
- I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags with the conductor or cable designation, origin, and destination.

- J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide [**heat-shrink preprinted tubes**] [**self-adhesive labels**] with the conductor designation.
- K. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- L. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- N. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
  - 1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
  - 2. Wall surfaces directly external to raceways concealed within wall.
  - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- O. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- P. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- Q. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
  - 1. Apply to exterior of door, cover, or other access.
  - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
    - a. Power-transfer switches.
    - b. Controls with external control power connections.
- R. Arc Flash Warning Labeling: Self-adhesive labels.
- S. Operating Instruction Signs: Self-adhesive labels.
- T. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- U. Equipment Identification Labels:
  - 1. Indoor Equipment: Self-adhesive label.
  - 2. Outdoor Equipment: Laminated acrylic or melamine sign.
  - 3. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchgear.
- e. Switchboards.
- f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- g. Emergency system boxes and enclosures.
- h. Enclosed switches.
- i. Enclosed circuit breakers.
- j. Enclosed controllers.
- k. Variable-speed controllers.
- l. Push-button stations.
- m. Contactors.
- n. Remote-controlled switches, dimmer modules, and control devices.
- o. Battery-inverter units.
- p. Monitoring and control equipment.

**END OF SECTION**

## SECTION 26 05 73

### OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
  - 1. Study results shall be used to determine coordination of series-rated devices.

##### 1.03 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
  - 1. Coordination-study input data, including completed computer program input data sheets.
  - 2. Study and equipment evaluation reports.
  - 3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
    - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Coordination Study Software Developer.
- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

## **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. The following parts from the Protective Device Coordination Study Report:
      - 1) One-line diagram.
      - 2) Protective device coordination study.
      - 3) Time-current coordination curves.
    - b. Power system data.

## **1.07 QUALITY ASSURANCE**

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

## **PART 2 PRODUCTS**

### **2.01 COMPUTER SOFTWARE DEVELOPERS**

- A. Software Developers
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
  - 1. Optional Features:
    - a. Arcing faults.
    - b. Simultaneous faults.
    - c. Explicit negative sequence.



- d. Mutual coupling in zero sequence.

## 2.02 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
  - 1. Protective device designations and ampere ratings.
  - 2. Cable size and lengths.
  - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
- F. Protective Device Coordination Study:
  - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
    - a. Phase and Ground Relays:
      - 1) Device tag.
      - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
      - 3) Recommendations on improved relaying systems, if applicable.
    - b. Circuit Breakers:
      - 1) Adjustable pickups and time delays (long time, short time, ground).
      - 2) Adjustable time-current characteristic.
      - 3) Adjustable instantaneous pickup.
      - 4) Recommendations on improved trip systems, if applicable.
    - c. Fuses: Show current rating, voltage, and class.
- G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
  - 1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
  - 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
  - 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
  - 4. Plot the following listed characteristic curves, as applicable:

- a. Power utility's overcurrent protective device.
  - b. Medium-voltage equipment overcurrent relays.
  - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
  - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
  - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
  - f. Cables and conductors damage curves.
  - g. Ground-fault protective devices.
  - h. Motor-starting characteristics and motor damage points.
  - i. Generator short-circuit decrement curve and generator damage point.
  - j. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.
  6. Provide adequate time margins between device characteristics such that selective operation is achieved.
  7. Comments and recommendations for system improvements.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
  1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

#### **3.02 PROTECTIVE DEVICE COORDINATION STUDY**

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. The study shall be based on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
  1. To normal system low-voltage load buses where fault current is 10 kA or less.
  2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.

- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
    - a. Inrush current when first energized.
    - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
  2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- H. Motor Protection:
1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
  2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- J. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.
- K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
1. Electric utility's supply termination point.
  2. Switchgear.
  3. Low-voltage switchgear.
  4. Motor-control centers.
  5. Standby generators and automatic transfer switches.
  6. Branch circuit panelboards.
- M. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short-circuit ratings.
  2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

### **3.03 LOAD-FLOW AND VOLTAGE-DROP STUDY**

- A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:
  1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
  2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
  3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

### **3.04 MOTOR-STARTING STUDY**

- A. Perform a motor-starting study to analyze the transient effect of the system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of the motor starting on the power system stability.
- B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and <Insert applicable standards>, and voltage sags so as not to affect the operation of other utilization equipment on the system supplying the motor.

### **3.05 POWER SYSTEM DATA**

- A. Obtain all data necessary for the conduct of the overcurrent protective device study.
  1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
  2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
  3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
  1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  2. Electrical power utility impedance at the service.
  3. Power sources and ties.
  4. Short-circuit current at each system bus, three phase and line-to-ground.
  5. Full-load current of all loads.
  6. Voltage level at each bus.

7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
11. Maximum demands from service meters.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
16. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
  - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
  - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
  - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
  - d. Ratings, types, and settings of utility company's overcurrent protective devices.
  - e. Special overcurrent protective device settings or types stipulated by utility company.
  - f. Time-current-characteristic curves of devices indicated to be coordinated.
  - g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
  - h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
  - i. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.
  - j. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

### **3.06 FIELD ADJUSTING**

- A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the

engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

### **3.07 DEMONSTRATION**

- A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:
  - 1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
  - 2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
  - 3. Adjust, operate, and maintain overcurrent protective device settings.

**END OF SECTION**

## SECTION 26 05 74

### OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

#### PART 1 GENERAL

##### 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.02 SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

##### 1.03 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

##### 1.04 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals **[shall]** **[may]** be in digital form.
  - 1. Arc-flash study input data, including completed computer program input data sheets.
  - 2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
    - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

##### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **Arc-Flash Study Software Developer**.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

##### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
  - 1. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

## **1.07 QUALITY ASSURANCE**

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

## **PART 2 PRODUCTS**

### **2.01 COMPUTER SOFTWARE DEVELOPERS**

- A. Comply with IEEE 1584 and NFPA 70E.
- B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

### **2.02 ARC-FLASH STUDY REPORT CONTENT**

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope.
- C. One-line diagram, showing the following:
  1. Protective device designations and ampere ratings.
  2. Cable size and lengths.
  3. Transformer kilovolt ampere (kVA) and voltage ratings.
  4. Motor and generator designations and kVA ratings.
  5. Switchgear, switchboard, motor-control center and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
- F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."



G. Arc-Flash Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
  - a. Voltage.
  - b. Calculated symmetrical fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. No AC Decrement (NACD) ratio.
  - e. Equivalent impedance.
  - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
  - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
  2. Protective device clearing time.
  3. Duration of arc.
  4. Arc-flash boundary.
  5. Working distance.
  6. Incident energy.
  7. Hazard risk category.
  8. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

**2.03 ARC-FLASH WARNING LABELS**

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a **3.5-by-5-inch (76-by-127-mm)** self-adhesive equipment label for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
1. Location designation.
  2. Nominal voltage.
  3. Flash protection boundary.
  4. Hazard risk category.
  5. Incident energy.
  6. Working distance.
  7. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

### **3.02 ARC-FLASH HAZARD ANALYSIS**

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies:
  - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
  - 2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."
- C. Calculate maximum and minimum contributions of fault-current size.
  - 1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
  - 2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.
- F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
  - 1. Fault contribution from induction motors should not be considered beyond three to five cycles.
  - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
  - 1. When the circuit breaker is in a separate enclosure.
  - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

### 3.03 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
1. Verify completeness of data supplied on the one-line diagram on Drawings[ **and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article**]. Call discrepancies to the attention of Architect.
  2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
  3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  2. Obtain electrical power utility impedance at the service.
  3. Power sources and ties.
  4. Short-circuit current at each system bus, three phase and line-to-ground.
  5. Full-load current of all loads.
  6. Voltage level at each bus.
  7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
  8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
  9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
  10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
  11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
  12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
  13. Motor horsepower and NEMA MG 1 code letter designation.
  14. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
  15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

### **3.04 LABELING**

- A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:
1. Motor-control center.
  2. Low-voltage switchboard.
  3. Switchgear.
  4. Control panel.

### **3.05 APPLICATION OF WARNING LABELS**

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

### **3.06 DEMONSTRATION**

- A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

**END OF SECTION**

## **SECTION 26 09 23**

### **LIGHTING CONTROL DEVICES**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching and dimming controls.
4. Indoor occupancy and vacancy sensors.
5. Switchbox-mounted occupancy sensors.
6. Digital timer light switches.
7. High-bay occupancy sensors.
8. Extreme temperature occupancy sensors.
9. Outdoor motion sensors.
10. Lighting contactors.
11. Emergency shunt relays.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

##### **1.03 ACTION SUBMITTALS**

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:
  - a. Occupancy sensors.
  - b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

##### **1.04 INFORMATIONAL SUBMITTALS**

A. Coordination Drawings: Reflected ceiling plan(s) and elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment will be attached.
3. Items penetrating finished ceiling, including the following:
  - a. Luminaires.
  - b. Air outlets and inlets.
  - c. Speakers.

- d. Sprinklers.
  - e. Access panels.
  - f. Control modules.
- B. Field quality-control reports.
- C. Sample Warranty: For manufacturer's warranties.

### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
- 1. Software operating and upgrade manuals.
  - 2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.

### 1.06 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
- 1. Failures include, but are not limited to, the following:
    - a. Faulty operation of lighting control software.
    - b. Faulty operation of lighting control devices.
  - 2. Warranty Period: **Two** year(s) from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.01 TIME SWITCHES

- A. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
- 1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
  - 2. Contact Configuration: SPST.
  - 3. Contact Rating: 30-A inductive or resistive, 240-Vac.
  - 4. Programs: Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
  - 5. Programs: Eight channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
  - 6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
  - 7. Astronomic Time: All channels.
  - 8. Automatic daylight savings time changeover.
  - 9. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.
- B. Electromechanical-Dial Time Switches: Comply with UL 917.

## 2.02 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Description: Solid state, with SPST dry contacts rated for 1000 W incandescent to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
  3. Time Delay: Fifteen-second minimum, to prevent false operation.
  4. Surge Protection: Metal-oxide varistor.
  5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
  6. Failure Mode: Luminaire stays ON.

## 2.03 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. General Requirements for Sensors:
1. Wall Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
  2. Dual technology.
  3. Integrated power pack.
  4. Hardwired connection to switch and BAS and lighting control system.
  5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  6. Operation:
    - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    - c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
  7. Sensor Output: Sensor is powered from the power pack.
  8. Power: Line voltage.
  9. Power Pack: Dry contacts rated for 20-A ballast or LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
  10. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.

- b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
  - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
  12. Bypass Switch: Override the "on" function in case of sensor failure.
  13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
- B. Dual-Technology Type: Wall Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
  2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet (110 square meters). when mounted 48 inches (1200 mm) above finished floor.

## **2.04 SWITCHBOX-MOUNTED OCCUPANCY SENSORS**

- A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
  3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
  4. Switch Rating: Not less than 800-VA ballast or LED load at 120 V, 1200-VA ballast or LED load at 277 V, and 800-W incandescent.
- B. Wall-Switch Sensor Tag WS1:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m) 2100 sq. ft (196 sq. m).
  2. Sensing Technology: PIR Dual technology - PIR and ultrasonic.
  3. Switch Type: SP. SP, dual circuit. SP, manual "on," automatic "off." SP, field-selectable automatic "on," or manual "on," automatic "off."
  4. Capable of controlling load in three-way application.



5. Voltage: Match the circuit voltage 120 V, 277 V, Dual voltage - 120 and 277 V.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Color: White, Black
11. Faceplate: Color matched to switch.

## **2.05 LIGHTING CONTACTORS**

- A. Description: Electrically operated and electrically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
  2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  3. Enclosure: Comply with NEMA 250.
  4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

## **2.06 EMERGENCY SHUNT RELAY**

- A. Description: NC, electrically held relay, arranged for wiring in parallel with manual [**or automatic**] switching contacts; complying with UL 924.
1. Coil Rating: Universal V.

## **2.07 CONDUCTORS AND CABLES**

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 SENSOR INSTALLATION**

- A. Comply with NECA 1.

- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

### **3.03 CONTACTOR INSTALLATION**

- A. Comply with NECA 1.
- B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

### **3.04 WIRING INSTALLATION**

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

### **3.05 IDENTIFICATION**

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

### **3.06 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Lighting control devices will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### **3.07 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
  - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

### **3.08 SOFTWARE SERVICE AGREEMENT**

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. 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 shall include operating system and new or revised licenses for using software.
  - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

### **3.09 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train. Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

**END OF SECTION**



## **SECTION 26 22 00**

### **LOW-VOLTAGE TRANSFORMERS**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

A. Section Includes: Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

##### **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 and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

##### **1.04 INFORMATIONAL SUBMITTALS**

A. Seismic Qualification Certificates: For transformers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Qualification Data: For testing agency.

C. Source quality-control reports.

D. Field quality-control reports.

##### **1.05 CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

##### **1.06 QUALITY ASSURANCE**

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Source Limitations: Obtain each transformer type from single source from single manufacturer.

### **2.02 GENERAL TRANSFORMER REQUIREMENTS**

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- 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.
- C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.
- D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
- E. Coils: Continuous windings without splices except for taps.
  1. Internal Coil Connections: Brazed or pressure type.
  2. Coil Material: Aluminum.
- F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

### **2.03 DISTRIBUTION TRANSFORMERS**

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated.
  1. NEMA 250, Type 3R: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
  2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
  1. Finish Color: Gray.
- F. Taps for Transformers 3 kVA and Smaller: None.
- G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- I. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150-deg C rise above 40-deg C ambient temperature.
- K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
  - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
  - 2. Indicate value of K-factor on transformer nameplate.
  - 3. Unit shall meet requirements of NEMA TP 1 when tested according to NEMA TP 2 with a K-factor equal to one.
- L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
  - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  - 2. Include special terminal for grounding the shield.
- M. Neutral: Rated 200 percent of full load current for K-factor rated transformers.
- N. Wall Brackets: Wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.
- O. Fungus Proofing: Permanent fungicidal treatment for coil and core.
- P. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
  - 1. 9 kVA and Less:
  - 2. 30 to 50 kVA:
  - 3. 51 to 150 kVA:
  - 4. 151 to 300 kVA:
  - 5. 301 to 500 kVA:
  - 6. 501 to 750 kVA:
  - 7. 751 to 1000 kVA:
  - 8. 1001 to 1500 kVA:

#### **2.04 BUCK-BOOST TRANSFORMERS**

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall be listed and labeled as complying with UL 506 or UL 1561.
  - 1. Standard impedance at 60Hz: 2 percent to 5 percent (up to 10 kVA), 4 percent to 6.5 percent (above 10 kVA).
  - 2. Nameplate Rating: Linear load, 60Hz.
  - 3. Insulation Class: 220 deg C system.

4. Temperature Rise: 150 deg C.
5. Core Construction: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
6. Coil Conductors: Continuous aluminum windings, with terminations brazed, welded, or bolted.
7. Coil Impregnation: Vacuum impregnated with polyester resin.
8. Sound Level: Not exceeding values listed above for distribution transformers.
9. Enclosure: Ventilated, NEMA 250, Type 3R.
10. Terminations: Transformer coils shall terminate in mounting pads. Mounting lugs shall be provided on all units up to and including 270 A ratings.
11. Antivibration pads or isolators shall be used between the transformer core and coil and the enclosure.
12. Ground core and coil assembly to enclosure with a flexible copper grounding strap or equivalent.
13. Mounting:
  - a. Ventilated Units up to 750 lb (340 kg): Suitable for wall, floor, or ceiling mounting (drip plate required).
  - b. Ventilated Units over 750 lb (340 kg): Suitable for floor mounting only.
  - c. Encapsulated Units up to 285 lb (130 kg): Suitable for wall or floor mounting.
  - d. Encapsulated Units over 285 lb (130 kg): Suitable for floor mounting only.
14. Seismic: Floor-mounted units comply with Earthquake Loads Section of International Building Code with site-specific parameters.

B. Enclosure: Ventilated NEMA 250, Type 2.

1. Finish Color: Gray.

## **2.05 IDENTIFICATION DEVICES**

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

## **2.06 SOURCE QUALITY CONTROL**

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
2. Ratio tests at the rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at the rated voltage connections.
4. No load losses, and excitation current and rated voltage at the rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation Resistance Tests:
  - a. High-voltage to ground.



- b. Low-voltage to ground.
  - c. High-voltage to low-voltage.
- 9. Temperature tests.
- B. Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 INSTALLATION**

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.
  - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
  - 2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
  - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

### **3.03 CONNECTIONS**

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

### **3.04 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
- F. Remove and replace units that do not pass tests or inspections and retest as specified above.
- G. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
  - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  - 2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
  - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- H. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

### **3.05 ADJUSTING**

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

**3.06 CLEANING**

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

**END OF SECTION**



## **SECTION 26 24 13**

### **SWITCHBOARDS**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.
8. Mimic bus.

##### **1.03 RELATED SECTIONS**

A. Section 260574 "Overcurrent Protective Device Arc-Flash Study" for arc-flash study and arc-flash label requirements.

##### **1.04 ACTION SUBMITTALS**

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of NRTL listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
  10. Include diagram and details of proposed mimic bus.
  11. Include schematic and wiring diagrams for power, signal, and control wiring.
- C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.
- D. Delegated Design Submittal:
1. For arc-flash hazard study.
  2. For arc-flash labels.

### **1.05 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field Quality-Control Reports:
1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Routine maintenance requirements for switchboards and all installed components.
    - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
    - c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

### **1.07 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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.

2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

#### **1.08 QUALITY ASSURANCE**

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
  1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

#### **1.09 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
- C. Handle and prepare switchboards for installation according to NECA 400.

#### **1.10 FIELD CONDITIONS**

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
  1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
    - b. Altitude: Not exceeding 6600 feet (2000 m).
- C. Unusual Service Conditions: NEMA PB 2, as follows:
  1. Ambient temperatures within limits specified.
  2. Altitude not exceeding 6600 feet (2000 m).
- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Architect's written permission.
4. Comply with NFPA 70E.

### **1.11 COORDINATION**

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

### **1.12 WARRANTY**

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Three years from date of Substantial Completion.
- B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Five years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
  2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

### **2.02 SWITCHBOARDS**

- A. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. 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.
- D. Comply with NEMA PB 2.



- E. Comply with NFPA 70.
- F. Comply with UL 891.
- G. Front-Connected, Front-Accessible Switchboards:
  - 1. Main Devices: Panel mounted.
  - 2. Branch Devices: Panel mounted.
  - 3. Sections front and rear aligned.
- H. Nominal System Voltage: 480Y/277 V.
- I. Main-Bus Continuous: 4000 A.
- J. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- K. Indoor Enclosures: Steel, NEMA 250, Type 1.
- L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- M. Barriers: Between adjacent switchboard sections.
- N. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- O. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.
- P. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- R. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard.
- S. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- T. Pull Box on Top of Switchboard:
  - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.

2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

U. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity.
3. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
4. Copper feeder circuit-breaker line connections.
5. Tin-plated aluminum feeder circuit-breaker line connections.
6. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
7. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
8. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
9. Disconnect Links:
  - a. Isolate neutral bus from incoming neutral conductors.
  - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
10. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
11. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
12. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

V. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

W. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

X. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

## 2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long and short time adjustments.
    - d. Ground-fault pickup level, time delay, and I squared t response.
  4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
  6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
  7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
  8. MCCB Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    - f. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
    - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at **[55]** **[75]** percent of rated voltage.
    - h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

- i. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

## **2.04 INSTRUMENTATION**

- A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
  - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
    - d. Megawatts: Plus or minus 1 percent.
    - e. Megavars: Plus or minus 1 percent.
    - f. Power Factor: Plus or minus 1 percent.
    - g. Frequency: Plus or minus 0.1 percent.
    - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
    - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
    - j. Contact devices to operate remote impulse-totalizing demand meter.
  - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- B. Watt-Hour Meters and Wattmeters:
  - 1. Comply with ANSI C12.1.
  - 2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
  - 3. Suitable for connection to three- and four-wire circuits.
  - 4. Potential indicating lamps.
  - 5. Adjustments for light and full load, phase balance, and power factor.
  - 6. Four-dial clock register.
  - 7. Integral demand indicator.
  - 8. Contact devices to operate remote impulse-totalizing demand meter.
  - 9. Ratchets to prevent reverse rotation.
  - 10. Removable meter with drawout test plug.
  - 11. Semiflush mounted case with matching cover.
  - 12. Appropriate multiplier tag.
- C. Impulse-Totalizing Demand Meter:
  - 1. Comply with ANSI C12.1.

2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording five minute integrated demand of totalized system.

## **2.05 CONTROL POWER**

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control Circuits: 120-V ac, supplied from remote branch circuit.
- C. Control Circuits: 24-V dc.
- D. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- E. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## **2.06 ACCESSORY COMPONENTS AND FEATURES**

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.
- C. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

## **2.07 IDENTIFICATION**

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Receive, inspect, handle, and store switchboards according to **NECA 400**.
  1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
  2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
  3. Protect from moisture, dust, dirt, and debris during storage and installation.
  4. Install temporary heating during storage per manufacturer's instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Install switchboards and accessories according to **NECA 400**.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in **Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."**
  - 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches (50-mm) above concrete base after switchboard is anchored in place.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to switchboards.
  - 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Install overcurrent protective devices, surge protection devices, and instrumentation.
  - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- H. Install spare-fuse cabinet.
- I. Comply with NECA 1.

### **3.03 CONNECTIONS**

- A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

- C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.
- D. Support and secure conductors within the switchboard according to NFPA 70.
- E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

### **3.04 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### **3.05 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Acceptance Testing:
    - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
    - b. Test continuity of each circuit.
  - 2. Test ground-fault protection of equipment for service equipment per NFPA 70.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 5. Perform the following infrared scan tests and inspections, and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:

- 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.06 ADJUSTING**

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated, as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

### **3.07 PROTECTION**

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

### **3.08 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

**END OF SECTION**



## **SECTION 26 24 16**

### **PANELBOARDS**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.

##### **1.03 DEFINITIONS**

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

##### **1.04 ACTION SUBMITTALS**

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

#### **1.05 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards. [**Submit final versions after load balancing.**]

#### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

#### **1.07 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. Keys: Two spares for each type of panelboard cabinet lock.
  2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
  3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

#### **1.08 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

#### **1.09 DELIVERY, STORAGE, AND HANDLING**

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

#### **1.10 FIELD CONDITIONS**

- A. Environmental Limitations:
  1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).

- b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Architect no fewer than two days in advance of proposed interruption of electric service.
  - 2. Do not proceed with interruption of electric service without Architect's written permission.
  - 3. Comply with NFPA 70E.

### **1.11 WARRANTY**

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
  - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
  - 1. SPD Warranty Period: Five years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.01 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS**

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. 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.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: Flush and Surface-mounted, dead-front cabinets.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3R.
    - c. Kitchen Wash-Down Areas: NEMA 250, Type 4X stainless steel.
    - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
  - 2. Height: 84 inches (2.13 m) maximum.

3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:
  - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
  - b. Back Boxes: Same finish as panels and trim.
  - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

G. Incoming Mains:

1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum.
  - a. Plating shall run entire length of bus.
  - b. Bus shall be fully rated the entire length.
2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
7. Split Bus: Vertical buses divided into individual vertical sections.

I. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
2. Terminations shall allow use of 75 deg C rated conductors without derating.

3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
  4. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.
  5. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.
  6. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  7. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  8. Gutter-Tap Lugs: Compression type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
  9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 20 percent.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

## **2.02 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD [**Type 1**] [**Type 2**].

## **2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS**

- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: [**Circuit breaker**] [**or**] [**lugs only**].

- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
  - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
  - 2. External Control-Power Source: 120-V branch circuit.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.
- G. Column-Type Panelboards: Single row of overcurrent devices.
  - 1. Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

## **2.04 ELECTRONIC-GRADE PANELBOARDS**

- A. Buses:
  - 1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
  - 2. Copper equipment and isolated ground buses.

## **2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES**

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers:
    - a. Inverse time-current element for low-level overloads.
    - b. Instantaneous magnetic trip element for short circuits.
    - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - 3. Electronic Trip Circuit Breakers:
    - a. RMS sensing.
    - b. Field-replaceable rating plug or electronic trip.
    - c. Digital display of settings, trip targets, and indicated metering displays.
    - d. Multi-button keypad to access programmable functions and monitored data.
    - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
    - f. Integral test jack for connection to portable test set or laptop computer.
    - g. Field-Adjustable Settings:
      - 1) Instantaneous trip.
      - 2) Long- and short-time pickup levels.
      - 3) Long and short time adjustments.

- 4) Ground-fault pickup level, time delay, and I squared T response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Breaker handle indicates tripped status.
  - c. UL listed for reverse connection without restrictive line or load ratings.
  - d. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
  - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
  - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - g. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
  - h. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.
  - i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  - j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
  - k. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
  - l. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
  - m. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  - n. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
  - o. Multipole units enclosed in a single housing with a single handle.

- p. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
- q. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

## **2.06 IDENTIFICATION**

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

## **2.07 ACCESSORY COMPONENTS AND FEATURES**

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to **NECA 407**.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to **NECA 407**.



D. Equipment Mounting:

1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."
2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
3. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

G. Mount top of trim 90 inches above finished floor unless otherwise indicated.

H. Mount panelboard cabinet plumb and rigid without distortion of box.

I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.

K. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (25 mm) empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

P. Mount spare fuse cabinet in accessible location.

### 3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

### **3.04 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. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Do not perform optional tests. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.05 ADJUSTING**

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

### **3.06 PROTECTION**

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

**END OF SECTION**



## **SECTION 26 27 26**

### **WIRING DEVICES**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

- A. Section Includes:
  - 1. Straight-blade convenience, hospital-grade, isolated-ground, and tamper-resistant receptacles.
  - 2. USB charger devices.
  - 3. GFCI receptacles.
  - 4. SPD receptacles.
  - 5. Hazardous (classified) location receptacles.
  - 6. Twist-locking receptacles.
  - 7. Pendant cord-connector devices.
  - 8. Cord and plug sets.
  - 9. Toggle switches.
  - 10. Wall switch sensor light switches with dual technology sensors.
  - 11. Wall plates.
  - 12. Floor service outlets.
  - 13. Prefabricated multioutlet assemblies.

##### **1.03 DEFINITIONS**

- A. Abbreviations of Manufacturers' Names:
  - 1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
  - 2. Hubbell: Hubbell Incorporated; Wiring Devices-Kellems.
  - 3. Leviton: Leviton Mfg. Company, Inc.
  - 4. Pass & Seymour: Pass& Seymour/Legrand.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.
- H. UTP: Unshielded twisted pair.

##### **1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

- C. Samples: One for each type of device and wall plate specified, in each color specified.

#### **1.05 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

#### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

#### **1.07 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. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
  - 2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
  - 3. SPD Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

### **PART 2 PRODUCTS**

#### **2.01 GENERAL WIRING-DEVICE REQUIREMENTS**

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
  - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
  - 2. Devices shall comply with the requirements in this Section.
- D. Devices for Owner-Furnished Equipment:
  - 1. Receptacles: Match plug configurations.
  - 2. Cord and Plug Sets: Match equipment requirements.
- E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

#### **2.02 STRAIGHT-BLADE RECEPTACLES**

- A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
- B. Isolated-Ground, Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
  - 1. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

- C. Tamper-Resistant Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
  - 1. Description: Labeled and complying with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

### **2.03 USB CHARGER DEVICES**

- A. Tamper-Resistant, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.
  - 1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
  - 2. USB Receptacles: Dual, Type A.
  - 3. Line Voltage Receptacles: Single, two pole, three wire, and self-grounding.

### **2.04 GFCI RECEPTACLES**

- A. General Description:
  - 1. 125 V, 20 A, straight blade, feed-through type.
  - 2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
  - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles:
- C. Tamper-Resistant, Duplex GFCI Convenience Receptacles:

### **2.05 SPD RECEPTACLES**

- A. General Description: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1449, and FS W-C-596, with integral SPD in line to ground, line to neutral, and neutral to ground.
  - 1. 125 V, 20 A, straight-blade type.
  - 2. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
  - 3. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
- B. Duplex SPD Convenience Receptacles:

### **2.06 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES**

- A. Hazardous (Classified) Locations Receptacles: Comply with NEMA FB 11 and UL 1010.

### **2.07 TWIST-LOCKING RECEPTACLES**

- A. Twist-Lock, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

### **2.08 PENDANT CORD-CONNECTOR DEVICES**

- A. Description:
  - 1. Matching, locking-type plug and receptacle body connector.
  - 2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
  - 3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

## **2.09 CORD AND PLUG SETS**

- A. Description:
  1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
  2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
  3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

## **2.10 TOGGLE SWITCHES**

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
  1. Single Pole:
  2. Two Pole:
  3. Three Way:
  4. Four Way:
- C. Pilot-Light Switches: 120/277 V, 20 A.
  1. Description: Single pole, with LED-lighted handle, illuminated when switch is off.
- D. Key-Operated Switches: 120/277 V, 20 A.
  1. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

## **2.11 WALL SWITCH SENSOR LIGHT SWITCH, DUAL TECHNOLOGY**

- A. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual technology.
  1. Connections: Provisions for connection to BAS.
  2. Connections: Hard wired.
  3. Connections: Wireless.
  4. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/4 hp at 120-V ac.
  5. Integral relay for connection to BAS.
  6. Adjustable time delay of 10 minutes.
  7. Able to be locked to Manual-On mode.
  8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux).
  9. Comply with NEMA WD 1, UL 20, and FS W-S-896.



## **2.12 WALL PLATES**

- A. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
  - 3. Material for Unfinished Spaces: Galvanized steel.
  - 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.

## **2.13 FLOOR SERVICE FITTINGS**

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Data Communication Outlet: Blank cover with bushed cable opening.

## **2.14 PREFABRICATED MULTIOUTLET ASSEMBLIES**

- A. Description:
  - 1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
  - 2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- B. Raceway Material: Metal, with manufacturer's standard finish.
- C. Multioutlet Harness:
  - 1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
  - 2. Receptacle Spacing: 6 inches (150 mm).
  - 3. Wiring: No. 12 AWG solid, Type THHN copper, single circuit.

## **2.15 FINISHES**

- A. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. Wiring Devices Connected to Emergency Power System: Red.
  - 3. SPD Devices: Blue.
  - 4. Isolated-Ground Receptacles: Orange.
- B. Wall Plate Color: For plastic covers, match device color.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
  - 4. Existing Conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
    - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
  - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
  - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
  - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
  - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
  - 8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
  1. Install ground pin of vertically mounted receptacles [**up**] [**down**], and on horizontally mounted receptacles to the [**right**] [**left**].
  2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

### **3.02 GFCI RECEPTACLES**

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

### **3.03 IDENTIFICATION**

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

### **3.04 FIELD QUALITY CONTROL**

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections:
  1. Test Instruments: Use instruments that comply with UL 1436.
  2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for Convenience Receptacles:
  1. Line Voltage: Acceptable range is 105 to 132 V.
  2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
  3. Ground Impedance: Values of up to 2 ohms are acceptable.
  4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  5. Using the test plug, verify that the device and its outlet box are securely mounted.
  6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- E. Test straight-blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

- F. Wiring device will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

**END OF SECTION**

## SECTION 26 28 13

### FUSES

#### PART 1 GENERAL

##### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
  - a. Control circuits.
  - b. Enclosed controllers.
  - c. Enclosed switches.
2. Spare-fuse cabinets.

##### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
  - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
  - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

##### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.

4. Coordination charts and tables and related data.

### **1.5 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

### **1.6 FIELD CONDITIONS**

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

### **2.2 CARTRIDGE FUSES**

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: [250] [600]-V, zero- to 600-A rating, 200 kAIC[, time delay].

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.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

### **2.3 SPARE-FUSE CABINET**

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 FUSE APPLICATIONS**

#### **A. Cartridge Fuses:**

1. Motor Branch Circuits: Class RK1 time delay.
2. Large Motor Branch (601-4000 A): Class L, time delay.
3. Other Branch Circuits: Class RK1, time delay.
4. Control Transformer Circuits: Class CC, time delay, control transformer duty.
5. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

### **3.3 INSTALLATION**

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Architect.

### **3.4 IDENTIFICATION**

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

**END OF SECTION**





**SECTION 26 28 16**  
**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

**1.02 SUMMARY**

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Molded-case circuit breakers (MCCBs).
  - 3. Enclosures.

**1.03 DEFINITIONS**

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

**1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Include wiring diagrams for power, signal, and control wiring.

**1.05 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified testing agency.

- B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

**1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
    - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

**1.07 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Fuse Pullers: Two for each size and type.

**1.08 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

**1.09 FIELD CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
  - 2. Altitude: Not exceeding 6600 feet (2010 m).

**1.10 WARRANTY**

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: One year(s) from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

### **2.02 GENERAL REQUIREMENTS**

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

### **2.03 FUSIBLE SWITCHES**

- A. Type HD, Heavy Duty:
  - 1. Double throw.
  - 2. Three pole.
  - 3. 240 - 600-V ac.
  - 4. 1200 A and smaller.
  - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified indicated fuses.
  - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- B. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
  - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 5. Auxiliary Contact Kit: [**One**] [**Two**] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - [**24-V ac**] [**120-V ac**] [**208-V ac**] [**240-V ac**] [**6-V dc**] [**12-V dc**] [**24-V dc**].
  - 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - 7. Lugs: [**Mechanical**] [**Compression**] type, suitable for number, size, and conductor material.
  - 8. Service-Rated Switches: Labeled for use as service equipment.

## 2.04 MOLDED-CASE CIRCUIT BREAKERS

- A. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- B. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- C. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated, Circuit breaker/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end-use equipment along with the statement "Caution - Series Rated System. \_\_\_\_ Amps Available. Identical Replacement Component Required."
- D. MCCBs shall be equipped with a device for locking in the isolated position.
- E. Lugs shall be suitable for 167 deg F (75 deg C) rated wire.
- F. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- G. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- H. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- I. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - 1. Instantaneous trip.
  - 2. Long- and short-time pickup levels.
  - 3. Long- and short-time time adjustments.
  - 4. Ground-fault pickup level, time delay, and I-squared t response.
- J. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- K. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- L. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- M. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- N. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: **Mechanical** type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
11. Zone-Selective Interlocking: Integral with electronic, ground-fault trip unit; for interlocking ground-fault protection function.
12. Electrical Operator: Provide remote control for on, off, and reset operations.
13. Accessory Control Power Voltage: Integrally mounted, self-powered, 24-V ac.

## **2.05 ENCLOSURES**

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

#### **3.02 PREPARATION**

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.
  - 2. Indicate method of providing temporary electric service.
  - 3. Do not proceed with interruption of electric service without Architect's written permission.
  - 4. Comply with NFPA 70E.

#### **3.03 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS**

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 3R.
  - 3. Kitchen, Wash-Down Areas: NEMA 250, [Type 4X.
  - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
  - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  - 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

#### **3.04 INSTALLATION**

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

### **3.05 IDENTIFICATION**

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### **3.06 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections for Switches:
  - 1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, grounding, and clearances.
    - c. Verify that the unit is clean.
    - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
    - e. Verify that fuse sizes and types match the Specifications and Drawings.
    - f. Verify that each fuse has adequate mechanical support and contact integrity.
    - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
      - 1) Use a low-resistance ohmmeter.
        - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
        - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
    - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
    - i. Verify correct phase barrier installation.
    - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

F. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that the unit is clean.
- e. Operate the circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the two following methods:
  - 1) Use a low-resistance ohmmeter.
    - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
    - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.



2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
  - e. Determine the following by primary current injection:
    - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
  - f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
  - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
  - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
  - i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  4. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- H. Prepare test and inspection reports.
1. Test procedures used.
  2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
  3. List deficiencies detected, remedial action taken, and observations after remedial action.

### **3.07 ADJUSTING**

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

**END OF SECTION**

## **SECTION 26 29 13**

### **ENCLOSED CONTROLLERS**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.
3. Reduced-voltage magnetic.
4. Reduced-voltage solid state.
5. Multispeed.

##### **1.03 DEFINITIONS**

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

##### **1.04 PERFORMANCE REQUIREMENTS**

A. Seismic Performance: Enclosed controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

##### **1.05 ACTION SUBMITTALS**

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Show tabulations of the following:
  - a. Each installed unit's type and details.
  - b. Factory-installed devices.
  - c. Nameplate legends.
  - d. Short-circuit current rating of integrated unit.
  - e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.

- f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
2. Wiring Diagrams: For power, signal, and control wiring.

#### **1.06 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
- D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

#### **1.07 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  1. Routine maintenance requirements for enclosed controllers and installed components.
  2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
  3. Manufacturer's written instructions for setting field-adjustable overload relays.
  4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

#### **1.08 MATERIALS MAINTENANCE 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. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  3. Indicating Lights: Two of each type and color installed.
  4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
  5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

## **1.09 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- 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.
- C. Comply with NFPA 70.
- D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

## **1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

## **1.11 PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
  - 2. Altitude: Not exceeding 6600 feet (2010 m).
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Architect no fewer than two days in advance of proposed interruption of electrical systems.
  - 2. Indicate method of providing temporary utilities.
  - 3. Do not proceed with interruption of electrical systems without Architect's written permission.
  - 4. Comply with NFPA 70E.

## **1.12 COORDINATION**

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

## **PART 2 PRODUCTS**

### **2.01 FULL-VOLTAGE CONTROLLERS**

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
  - 1. Configuration: Nonreversing.
  - 2. Surface mounting.
  - 3. Red pilot light.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
  - 1. Configuration: Nonreversing.
  - 2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
  - 3. Surface mounting.
  - 4. Red pilot light.
- D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
  - 1. Configuration: Nonreversing.
  - 2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
  - 3. Surface mounting.
  - 4. [Red] [Green] pilot light.
  - 5. N.O. auxiliary contact.
- E. Magnetic Controllers: Full voltage, across the line, electrically held.
  - 1. Configuration: Nonreversing.
  - 2. Contactor Coils: Pressure-encapsulated type.
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
  - 3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  - 4. Control Circuits: 24 V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. CPT Spare Capacity: 50 VA.
  - 5. Melting Alloy Overload Relays:
    - a. Inverse-time-current characteristic.
    - b. Class 10 tripping characteristic.

- c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
- 6. Solid-State Overload Relay:
  - a. Switch or dial selectable for motor running overload protection.
  - b. Sensors in each phase.
  - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
  - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
  - e. Analog communication module.
- 7. N.C., isolated overload alarm contact.
- 8. External overload reset push button.
- F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
  - 1. Fusible Disconnecting Means:
    - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
    - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  - 2. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
  - 3. Nonfusible Disconnecting Means:
    - a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
    - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
  - 4. MCP Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - d. N.C. alarm contact that operates only when MCP has tripped.
    - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
  - 5. MCCB Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

- c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
- e. [N.C.] [N.O.] alarm contact that operates only when MCCB has tripped.

## 2.02 REDUCED-VOLTAGE MAGNETIC CONTROLLERS

- A. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.
- B. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.
  - 1. Configuration:
    - a. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
    - b. Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
    - c. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
  - 2. Contactor Coils: Pressure-encapsulated type.
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
  - 3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  - 4. Control Circuits: 24-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. CPT Spare Capacity: 50 VA.
  - 5. Melting Alloy Overload Relays:
    - a. Inverse-time-current characteristic.
    - b. Class 10 tripping characteristic.
    - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  - 6. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor running overload protection.
    - b. Sensors in each phase.
    - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    - e. Analog communication module.
  - 7. N.C., isolated overload alarm contact.
  - 8. External overload reset push button.



- C. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
1. Fusible Disconnecting Means:
    - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
    - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
  2. MCP Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - d. N.C. alarm contact that operates only when MCP has tripped.
    - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
  3. MCCB Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
    - e. N.C. alarm contact that operates only when MCCB has tripped.

### **2.03 ENCLOSURES**

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
1. Dry and Clean Indoor Locations: Type 1.
  2. Outdoor Locations: Type 3R.
  3. [Kitchen] [Wash-Down] Areas: Type 4X, stainless steel.
  4. Other Wet or Damp Indoor Locations: Type 4.
  5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
  6. Hazardous Areas Indicated on Drawings: Type 7.

## 2.04 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  - 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
    - a. Push Buttons: Covered types; maintained as indicated.
    - b. Pilot Lights: LED types; colors as indicated; push to test.
    - c. Selector Switches: Rotary type.
  - 2. Elapsed Time Meters: Heavy duty with digital readout in hours; nonresettable.
  - 3. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.
- B. N.C. auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
- E. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- F. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- H. Cover gaskets for Type 1 enclosures.
- I. Terminals for connecting power factor correction capacitors to the [line] [load] side of overload relays.
- J. Spare control wiring terminal blocks, quantity as indicated[; unwired] [; wired].

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

- B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch (100-mm) nominal-thickness concrete base. Comply with requirements for concrete base specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."]
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 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.
- C. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in each fusible-switch enclosed controller.
- F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- G. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- I. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.
- J. Comply with NECA 1.

### **3.03 IDENTIFICATION**

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.

### **3.04 CONTROL WIRING INSTALLATION**

- A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### **3.05 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. 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.
- D. Acceptance Testing Preparation:
  1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
  2. Test continuity of each circuit.
- E. Tests and Inspections:
  1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
  3. Test continuity of each circuit.
  4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
  5. Test each motor for proper phase rotation.
  6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- F. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.06 ADJUSTING**

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers at 50 percent.
- E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.
- F. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

### **3.07 PROTECTION**

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

### **3.08 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers.

## **END OF SECTION**



## **SECTION 26 51 19**

### **LED INTERIOR LIGHTING**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

A. Section includes the following types of LED luminaires:

1. Cylinder.
2. Downlight.
3. Highbay, linear.
4. Linear industrial.
5. Lowbay.
6. Parking garage.
7. Recessed linear.
8. Strip light.
9. Surface mount, linear.
10. Surface mount, nonlinear.
11. Suspended, linear.
12. Suspended, nonlinear.
13. Materials.
14. Finishes.
15. Luminaire support.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

##### **1.03 DEFINITIONS**

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

##### **1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
1. Arrange in order of luminaire designation.
  2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaires.
  4. Include emergency lighting units, including batteries and chargers.
  5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
  6. Photometric data and adjustment factors based on laboratory tests[, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project] [IES LM-79] [and] [IES LM-80].
    - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
  2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

#### **1.05 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
  2. Suspended ceiling components.
  3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
  4. Structural members to which [equipment] [and] [or] luminaires will be attached.
  5. Initial access modules for acoustical tile, including size and locations.
  6. Items penetrating finished ceiling, including the following:
    - a. Other luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Ceiling-mounted projectors.
  7. Moldings.
  8. <Insert feature>.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.



- C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Product Certificates: For each type of luminaire.
- F. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- G. Sample warranty.

#### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

#### **1.07 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. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

#### **1.08 QUALITY ASSURANCE**

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
  - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
  - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

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.

#### **1.09 DELIVERY, STORAGE, AND HANDLING**

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

#### **1.10 WARRANTY**

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

### **PART 2 PRODUCTS**

#### **2.01 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
  1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

#### **2.02 LUMINAIRE 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. Standards:
  1. ENERGY STAR certified.
  2. California Title 24 compliant.
  3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
  4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
  5. UL Listing: Listed for damp location.
  6. Recessed luminaires shall comply with NEMA LE 4.
  7. User Replaceable Lamps:
    - a. Bulb shape complying with ANSI C78.79.
    - b. Lamp base complying with ANSI C81.61.
- C. CRI of minimum 80. CCT of 3500 k.
- D. Rated lamp life of 70,000 hours to L70.
- E. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- F. Internal driver.

G. Nominal Operating Voltage: Universal.

1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

H. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear anodized finish.

### **2.03 LINEAR INDUSTRIAL**

A. Minimum 5,000 lumens. Minimum allowable efficacy of 80 lumens per watt.

B. Housing and heat sink rated to the following:

1. IP 54.
2. CSA C22.2 No 137.

### **2.04 MATERIALS**

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Prismatic acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear anodized finish.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
  - a. "USE ONLY" and include specific lamp type.
  - b. Lamp diameter, shape, size, wattage, and coating.
  - c. CCT and CRI for all luminaires.

## **2.05 METAL FINISHES**

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

## **2.06 LUMINAIRE SUPPORT**

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 TEMPORARY LIGHTING**

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

### **3.03 INSTALLATION**

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and relamping.
  - 3. Provide support for luminaire without causing deflection of ceiling or wall.
  - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaire Support:
  - 1. Secured to outlet box.
  - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
  - 3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports 120 inches (6 m) in length.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

### **3.04 IDENTIFICATION**

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### **3.05 FIELD QUALITY CONTROL**

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

### **3.06 STARTUP SERVICE**

A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."

- B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

### **3.07 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
  - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
  - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 3. Adjust the aim of luminaires in the presence of the Architect.

**END OF SECTION**

## **SECTION 26 52 19**

### **EMERGENCY AND EXIT LIGHTING**

#### **PART 1 - GENERAL**

##### **1.01 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### **1.02 SUMMARY**

A. Section Includes:

1. Emergency lighting units.
2. Exit signs.
3. Luminaire supports.

##### **1.03 DEFINITIONS**

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

##### **1.04 ACTION SUBMITTALS**

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.
2. Include physical description of the unit and dimensions.
3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
  - a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by manufacturer.
  - b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.
- C. Samples: For each product and for each color and texture specified.
- D. Samples for Initial Selection: For each type of luminaire with factory-applied finishes.
- E. Samples for Verification: For each type of luminaire.
  1. Include Samples of luminaires and accessories to verify finish selection.
- F. Product Schedule:
  1. For emergency lighting units. Use same designations indicated on Drawings.
  2. For exit signs. Use same designations indicated on Drawings.

#### **1.05 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Luminaires.
  2. Suspended ceiling components.
  3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
  4. Structural members to which equipment will be attached.
  5. Size and location of initial access modules for acoustical tile.
  6. Items penetrating finished ceiling including the following:
    - a. Other luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Ceiling-mounted projectors.
    - e. Sprinklers.
    - f. Access panels.
  7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Product Certificates: For each type of luminaire.
- D. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  4. Provide seismic qualification certificate for each piece of equipment.
- E. Product Test Reports: For each luminaire for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Sample Warranty: For manufacturer's special warranty.



### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

### **1.07 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. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
  2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
  3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

### **1.08 QUALITY ASSURANCE**

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
1. Obtain Architect's approval of luminaires and signs in mockups before starting installations.
  2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  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.

### **1.09 DELIVERY, STORAGE, AND HANDLING**

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

### **1.10 WARRANTY**

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Two year(s) from date of Substantial Completion.

- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Emergency Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.
  2. Warranty Period for Self-Powered Exit Sign Batteries: Two years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining six years.

## **PART 2 - PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

### **2.02 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING**

- 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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Comply with UL 1598 for fluorescent luminaires.
- F. Lamp Base: Comply with ANSI C81.61.
- G. Bulb Shape: Complying with ANSI C79.1.
- H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
1. Emergency Connection: Operate one lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
  2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
    - b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).

- c. Humidity: More than 95 percent (condensing).
- d. Altitude: Exceeding 3300 feet (1000 m).
- 4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
  - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- 5. Battery: Sealed, maintenance-free, nickel-cadmium type.
- 6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
- 7. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
- 8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

### **2.03 EMERGENCY LIGHTING**

A. General Requirements for Emergency Lighting Units: Self-contained units.

B. Emergency Luminaires:

- 1. Emergency Luminaires: As indicated on Interior Luminaire Schedule, with the following additional features:
  - a. Operating at nominal voltage of 120 V ac or 277 V ac.
  - b. Internal emergency power unit.
  - c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
  - d. UL 94 flame rating.

C. Emergency Lighting Unit:

- 1. Emergency Lighting Unit: As indicated on Interior Luminaire Schedule.
- 2. Operating at nominal voltage of 120 V ac or 277 V ac.
- 3. Wall with universal junction box adaptor.
- 4. UV stable thermoplastic housing, rated for damp locations.
- 5. Two LED lamp heads.
- 6. Internal emergency power unit.

### **2.04 EXIT SIGNS**

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

- 1. Operating at nominal voltage of 120 V ac or 277 V ac.
- 2. Lamps for AC Operation: Fluorescent, two for each luminaire; 20,000 hours of rated lamp life.
- 3. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.

4. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

## **2.05 MATERIALS**

### A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

### B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

### C. Diffusers and Globes:

1. Prismatic acrylic.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
4. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

### D. Housings:

1. Extruded aluminum housing and heat sink.
2. Black anodized finish.

### E. Conduit: Electrical metallic tubing, minimum 3/4 inch (21 mm) in diameter.

## **2.06 METAL FINISHES**

- A. 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.

## **2.07 LUMINAIRE SUPPORT COMPONENTS**

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
  - 1. Sized and rated for luminaire and emergency power unit weight.
  - 2. Able to maintain luminaire position when testing emergency power unit.
  - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
  - 1. Attached to structural members in walls.
  - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
  - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
  - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Ceiling Grid Mounted Luminaires:
  - 1. Secure to any required outlet box.
  - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
  - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

### **3.03 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### **3.04 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

### **3.05 STARTUP SERVICE**

A. Perform startup service:

1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

### **3.06 ADJUSTING**

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
  - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
2. Conduct short-duration tests on all emergency lighting.

**END OF SECTION**

## **SECTION 31 10 00 SITE CLEARING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Clearing and protection of vegetation.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 10 00 - 01 10 00: Limitations on Contractor's use of site and premises.
- B. Section 01 50 00 - 01 50 00: Site fences, security, protective barriers, and waste removal.

### **PART 2 PRODUCTS -- NOT USED**

### **PART 3 EXECUTION**

#### **3.01 SITE CLEARING**

- A. Comply with other requirements specified in Section 01 70 00.
- B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

#### **3.02 EXISTING UTILITIES AND BUILT ELEMENTS**

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing irrigation system components.
- E. Protect existing structures and other elements that are not to be removed.

#### **3.03 VEGETATION**

- A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by lawns, and planting beds.
- B. Do not remove or damage vegetation beyond the limits indicated on drawings.
- C. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
  - 1) At vegetation removal limits.
  - 2) Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
- D. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.
- E. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
  - 1) Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
  - 2) Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
  - 3) Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
  - 4) Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.

- 5) Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.
- F. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to UCCS.

**3.04 DEBRIS**

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

**END OF SECTION**



## **SECTION 32 12 16 ASPHALT PAVING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Single course bituminous concrete paving.

#### **1.02 REFERENCE STANDARDS**

- A. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction; 2009a.

#### **1.03 FIELD CONDITIONS**

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.

### **PART 2 PRODUCTS**

#### **2.01 MATERIALS**

- A. Asphalt Cement: City of Colorado Springs Engineering Standard Specification Manual and MUTCD.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION - TACK COAT**

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd.

#### **3.02 PLACING ASPHALT PAVEMENT - SINGLE COURSE**

- A. Install Work in accordance with City of Colorado Springs Engineering Standard Specifications Manual and the MUTCD.
- B. Place asphalt within 24 hours of applying primer or tack coat.
- C. Place to 2" inch compacted thickness.
- D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- E. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

#### **3.03 PROTECTION**

- A. Immediately after placement, protect pavement from mechanical injury for 2 days or until surface temperature is less than 140 degrees F.

**END OF SECTION**



## **SECTION 32 13 13 CONCRETE PAVING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Concrete sidewalks, stair steps, and integral curbs.
- B. Accessories.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 20 00 - Concrete Reinforcing.
- C. Section 03 30 00 - 03 30 00. - Cast-In-Place-Concrete.
- D. Section 07 92 00 - Joint Sealants: Sealing joints.
- E. Section 32 17 23.13 - Painted Pavement Markings.

#### **1.03 REFERENCE STANDARDS**

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).
- B. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).
- C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000.
- D. ACI 305R - Hot Weather Concreting; 2010.
- E. ACI 306R - Cold Weather Concreting; 2010.
- F. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement; 2015.
- G. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2015a.
- H. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2015.
- I. ASTM C150/C150M - Standard Specification for Portland Cement; 2015.
- J. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2011.
- K. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2004 (Reapproved 2013).

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on joint filler, admixtures, and curing compound.
- C. Design Data: Indicate pavement thickness, designed concrete strength, reinforcement, and typical details.

### **PART 2 PRODUCTS**

#### **2.01 PAVING ASSEMBLIES**

- A. Comply with applicable requirements of ACI 301.
- B. Sidewalks, Utility Yard, and Parking Area Pavement: 4,000 psi 28 day concrete, depth as noted on contract drawings.

## **2.02 FORM MATERIALS**

- A. Form Materials: As specified in Section 03 10 00, conform to ACI 301.
- B. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751).
  - 1) Thickness: 1/2 inch.

## **2.03 REINFORCEMENT**

- A. Reinforcing Steel and Welded Wire Reinforcement: Types specified in Section 03 20 00.
- B. Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi yield strength; deformed billet steel bars; unfinished finish.

## **2.04 CONCRETE MATERIALS**

- A. Obtain cementitious materials from same source throughout.
- B. Cement: ASTM C150/C150M, Normal - Type I Portland cement, gray color.

## **2.05 ACCESSORIES**

- A. Curing Compound: ASTM C309, Type 1, Class A.
- B. Surface Retarder:
  - 1) Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
  - 2) Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
  - 3) Color: Clear.
- C. Cast Iron Nosings:
  - 1) Material: Cast Iron.
  - 2) Tread:
    - a. Pattern: Cross hatch 1/32" deep.
    - b. Surface: Anti-slip.
  - 3) Size:
    - a. Width: 4".
    - b. Thickness: 3/8".
    - c. Length: Width of stair minus 6" each side.
  - 4) Mounting: Cast-In-Bolt.
  - 5) Nosing Profile: Short tipped
  - 6) Acceptable Manufacturers:
    - a. Babcock - Davis
    - b. Balco
    - c. Nystrom
    - d. Substitutions: See Section 01 60 00 - 01 60 00.

## **2.06 CONCRETE MIX DESIGN**

- A. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
  - 1) For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- B. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- C. Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions.
- D. Steel Reinforcement: Per Section 03 20 00 where indicated.

- E. Concrete Properties:
- 1) Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 4000 psi.
  - 2) Fly Ash Content: Maximum 25 percent of cementitious materials by weight.
  - 3) Type I/II Cement with Cement Content: Minimum 540 lb per cubic yard.
  - 4) Water-Cement Ratio: Maximum 45 percent by weight.
  - 5) 6% +/- 1-1/2% Entrained Air.
  - 6) Maximum Slump: 4 inches.
  - 7) Maximum Aggregate Size: 3/4" inch.
  - 8) Water Reducing Agent: Use in accordance with manufacturer's recommendations.

## **2.07 MIXING**

- A. Transit Mixers: Comply with ASTM C94/C94M.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

### **3.02 FORMING**

- A. Place and secure forms to correct location, dimension, profile, and gradient.

### **3.03 REINFORCEMENT**

- A. Place reinforcement at top of slabs-on-grade.

### **3.04 PLACING CONCRETE**

- A. Place concrete as specified in Section 03 30 00.
- B. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.

### **3.05 JOINTS**

- A. Place 3/8 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.
- B. Provide sawn joints.
- 1) At five feet intervals unless otherwise noted on contract documents.
- C. Saw cut contraction joints 3/16 inch wide at an optimum time after finishing. Cut 1/3 into depth of slab.

### **3.06 FINISHING**

- A. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.
- B. Curbs and Gutters: Light broom, texture parallel to pavement direction.
- C. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

### **3.07 TOLERANCES**

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.

### **3.08 FIELD QUALITY CONTROL**

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.

- 1) Provide free access to concrete operations at project site and cooperate with appointed firm.
  - 2) Submit proposed mix design to inspection and testing firm for review prior to commencement of concrete operations.
- B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
- C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

### **3.09 PROTECTION**

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.

**END OF SECTION**

## **SECTION 32 17 23.13 PAINTED PAVEMENT MARKINGS**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Parking lot markings, including parking bays, crosswalks, handicapped symbols, and curb markings.
- B. "No Parking" curb painting.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 32 12 16 - Asphalt Paving.

#### **1.03 REFERENCE STANDARDS**

- A. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; current edition, [www.paintinfo.com](http://www.paintinfo.com).
- B. FHWA MUTCD - Manual on Uniform Traffic Control Devices for Streets and Highways; U.S. Department of Transportation, Federal Highway Administration; Current Edition.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. 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.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

#### **1.06 FIELD CONDITIONS**

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

### **PART 2 PRODUCTS**

#### **2.01 MATERIALS**

- A. Line and Zone Marking Paint: MPI No. 97 Latex Traffic Marking Paint; color(s) as indicated.
  - 1) Parking Lots: As selected by Architect.
  - 2) Handicapped Symbols: Blue.

### **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. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.

- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Clean surfaces thoroughly prior to installation.
  - 1) Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
- D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.
- E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.

### **3.03 INSTALLATION**

- A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.
- C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
- D. Comply with FHWA MUTCD manual (<http://mutcd.fhwa.dot.gov>) for details not shown.
- E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.
- F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on the drawings true, sharp edges and ends.
  - 1) Apply paint in one coat only.
  - 2) Wet Film Thickness: 0.015 inch, minimum.
  - 3) Width Tolerance: Plus or minus 1/8 inch.
- G. Parking Lots: Apply parking space lines, painted curbs, and other markings indicated on drawings.
  - 1) Mark the International Handicapped Symbol at indicated parking spaces.
  - 2) Hand application by pneumatic spray is acceptable.
- H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

### **3.04 DRYING, PROTECTION, AND REPLACEMENT**

- A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
- B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.
- C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.
- D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.
- E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.



F. Replace removed markings at no additional cost to UCCS.

**END OF SECTION**



## **SECTION 32 84 23**

### **UNDERGROUND SPRINKLERS**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Pipe and fittings, valves, sprinkler heads, and accessories.
- B. Control system.

##### **1.02 REFERENCE STANDARDS**

- A. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2015.
- B. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2012.

##### **1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate piping layout to water source, location of sleeves under pavement, location and coverage of sprinkler heads, components, plant and landscaping features, site structures, schedule of fittings to be used.
- C. Product Data: Provide component and control system and wiring diagrams.
- D. Samples: Provide one outlet of each type, with housing. Accepted samples may be used in the Work.
- E. Record Documents: Record actual locations of all concealed components piping system.
- F. Operation and Maintenance Data:
  - 1) Provide instructions for operation and maintenance of system and controls, seasonal activation and shutdown, and manufacturer's parts catalog.
  - 2) Provide schedule indicating length of time each valve is required to be open to provide a determined amount of water.
- G. Maintenance Materials: Provide the following for UCCS's use in maintenance of project.
  - 1) See Section 01 60 00 - 01 60 00, for additional provisions.
  - 2) Extra Sprinkler Heads: One of each type and size.
  - 3) Extra Valve Keys for Manual Valves: One.
  - 4) Extra Valve Box Keys: One.
  - 5) Wrenches: One for each type head core and for removing and installing each type head.

##### **1.04 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years of experience.

##### **1.05 REGULATORY REQUIREMENTS**

- A. Conform to applicable code for piping and component requirements.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of products in system.

## **PART 2 PRODUCTS**

### **2.01 IRRIGATION SYSTEM**

- A. Electric solenoid controlled underground irrigation system, with low point self drain. System to match UCCS Campus Standards.

### **2.02 PIPE MATERIALS**

- A. PVC Pipe: ASTM D2241; 200 psi pressure rated upstream from controls, 160 psi downstream; solvent welded sockets.
- B. Fittings: Type and style of connection to match pipe.
- C. Pipe Risers at Valves: 160 psi PVC pipe.
- D. Solvent Cement: ASTM D2564 for PVC pipe and fittings.
- E. Sleeve Material: PVC.

### **2.03 OUTLETS**

- A. Contact University of Colorado - Colorado Springs Project Manager for outlet manufacturer and types.

### **2.04 VALVES**

- A. Contact University of Colorado - Colorado Springs Project Manager for valve manufacturer and types.

### **2.05 CONTROLS**

- A. Contact University of Colorado - Colorado Springs Project Manager for Controller information.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify location of existing utilities.
- B. Verify that required utilities are available, in proper location, and ready for use.

### **3.02 PREPARATION**

- A. Piping layout indicated is diagrammatic only. Route piping to avoid plants, ground cover, and structures.
- B. Layout and stake locations of system components.
- C. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system.

### **3.03 TRENCHING**

- A. Trench to accommodate grade changes and slope to drains.
- B. Maintain trenches free of debris, material, or obstructions that may damage pipe.

### **3.04 INSTALLATION**

- A. Install pipe, valves, controls, and outlets in accordance with manufacturer's instructions.
- B. Connect to utilities.
- C. Set outlets and box covers at finish grade elevations.
- D. Provide for thermal movement of components in system.
- E. Use threaded nipples for risers to each outlet.
- F. Install control tubing in accordance with manufacturer's instructions. Provide 10 inch expansion coil in irrigation piping at each valve to which controls are connected, and at 100 ft intervals. Bury control tubing beside pipe.

- G. After piping is installed, but before outlets are installed and backfilling commences, open valves and flush system with full head of water.

**3.05 BACKFILLING**

- A. Provide 3 inch sand cover over piping.
- B. Backfill trench and compact to specified subgrade elevation. Protect piping from displacement.

**3.06 SYSTEM STARTUP**

- A. Prepare and start system in accordance with manufacturer's instructions.
- B. Adjust control system to achieve time cycles required.
- C. Adjust head types for full water coverage as directed.

**3.07 CLOSEOUT ACTIVITIES**

- A. Instruct UCCS's personnel in operation and maintenance of system, including adjusting of sprinkler heads. Use operation and maintenance data as basis for demonstration.

**3.08 MAINTENANCE**

- A. See Section 01 70 00 - 01 70 00, for additional requirements relating to maintenance service.
- B. Provide one complete spring start-up and a fall shutdown by installer, at no extra cost to UCCS.

**END OF SECTION**



## **SECTION 32 92 23**

### **SODDING**

#### **PART 1 GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Preparation of subsoil.
- B. Sod installation.

##### **1.02 RELATED REQUIREMENTS**

- A. 31 10 00 - Site Clearing: Removal of site items prior to grading and sod installation

##### **1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Certification: Submit certification of grass species and location of sod source.
- C. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height.

##### **1.04 QUALITY ASSURANCE**

- A. Sod Producer: Company specializing in sod production and harvesting with minimum five years experience, and certified by the State of Colorado.

##### **1.05 REGULATORY REQUIREMENTS**

- A. Comply with regulatory agencies for fertilizer and herbicide composition.

##### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver sod on pallets. Protect exposed roots from dehydration.
- B. Do not deliver more sod than can be laid within 24 hours.

##### **1.07 MAINTENANCE**

- A. See Section 01 70 00 - 01 70 00, for additional requirements relating to maintenance service.

#### **PART 2 PRODUCTS**

##### **2.01 MATERIALS**

- A. Sod, Type to match existing sod at north portion of site. Verify sod type with UCCS project manager.

##### **2.02 ACCESSORIES**

- A. Edging: Galvanized steel.
  - 1) Color: Match existing edging on site.
  - 2) Size: Match existing on site.

#### **PART 3 EXECUTION**

##### **3.01 EXAMINATION**

- A. Verify that prepared soil base is ready to receive the work of this section.
- B. Do not install sod before April 15 or after October 15 without approval of the UCCS Project Manager.
- C. Do not install sod on saturated or frozen soil.

##### **3.02 PREPARATION**

- A. Soil Preparation: In all areas where sod is to be installed, the following steps must be taken:

- 1) Topsoil - Strip existing 4" of topsoil and stockpile on site for future distribution in new turf areas.
  - 2) Soil Conditioner - Evenly distribute at a rate of 3 cubic yards per 1,000 sq.ft., A-1 Premium 3 Organic Compost or equal to be aged organic matter, meeting the following requirements:
    - a. Organic matter: 45% minimum. Organic material may be aged sawdust or other nitrogen-treated, decomposing wood products, direct pulverized poultry manure, humus, compost, aged treated pulverized manure, treated sewage sludge, other organic material as approved by the UCCS project manager. Prohibited materials include aspen humus and mountain peat.
    - b. Salt Content: 4.0 mmhos/com maximum.
    - c. ph range: 4.3 - 7.5.
  - 3) Fertilizer - First application fertilizer is required in all turf areas. Provide inorganic mixture with 4 lbs. of diammonium phosphate (18-46-0) per 1,000 sq.ft. tilled into depth of 6".
- B. Prepare subgrade in accordance with Section 31 22 00.

### **3.03 LAYING SOD**

- A. Moisten prepared surface immediately prior to laying sod.
- B. Lay sod immediately after delivery to site to prevent deterioration.
- C. Lay sod smooth and tight with no open joints visible, and no overlapping; stagger end joints 12 inches minimum. Do not stretch or overlap sod pieces.
- D. Where sod is placed adjacent to hard surfaces, such as curbs, pavements, etc., place top elevation of sod 1/2 inch below top of hard surface.
- E. On slopes 6 inches per foot and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.
- F. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.
- G. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

### **3.04 MAINTENANCE**

- A. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing until substantial completion of project.
- B. Immediately remove clippings after mowing and trimming.
- C. Water to prevent grass and soil from drying out.
- D. Roll surface to remove irregularities.
- E. Immediately replace sod to areas that show deterioration or bare spots.

**END OF SECTION**